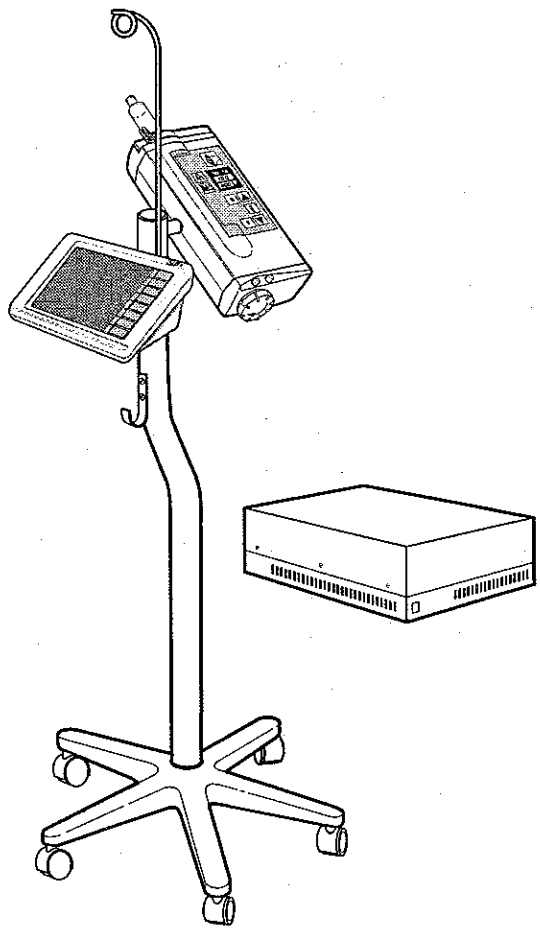
MALLINCKRODT

Liebel-Flarsheim

CT 9000® ADV

Digital Injection System



INSTALLATION SERVICE MANUAL

800961-C

The serial numbers and date of manufacture must be supplied when requesting replacement parts or optional accessories. For convenience, record the requested information below:

Base/Elect Cab S/N | | | | | | | | |

Powerhead S/N | | | | | | | | |

Console S/N | | | | | | | | |

Model Number | | | | | | | | | |

Date of Installation | | / | | / | |

Installing Company _____

Address _____

Phone No. _____

FOREWORD

Congratulations on your purchase of the Liebel-Flarsheim CT 9000™ ADV Digital Injection System. The CT 9000™ ADV represents our effort to provide a quality product to support better health care throughout the world.

Regardless of how well a piece of equipment is designed misuse or abuse will deny its owner the expected safe, efficient, and quality service. Often, misuse or abuse occurs unintentionally, simply because the proper method of operating or servicing the equipment is unknown. We urge you to carefully read this manual and the Operator's Manual before servicing the CT 9000™ ADV. Retain this manual for future reference.

MEANINGS OF SYMBOLS

Please regard any message that follows a Danger, Warning, or Caution symbol.

DANGER!*—Hazards which could result in severe personal injury or death.*
WARNING!*—Hazards which could result in personal injury.*
CAUTION!*—Hazards which could result in equipment or property damage.*

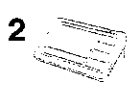
WARNING!*—Electrical hazards which could result in personal injury.*

Non- Anesthetic proof

Remote handswitch

Printer

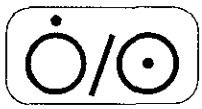
Primary console



Secondary console

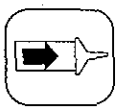
Powerhead

Toggle On/Off switch



Push-push On/Off

Viewing Angle Adjustment



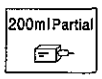
Injecting

Enabled (Ready)

Scan delay

Time

Date



Syringe volume/size

Patient volume

Protocol volume

Auto-Fill Key

Auto-Volume Key

Start/Stop Key

Auto Fill Volume Indicator

Syringe Size Indicator

Injection in Progress

Console and Powerpack classified EN 60601-1, Type B

Powerhead classified EN 60601-1, Type CF

Equipment Classification with respect to protection from electric shock: Class 1

CE 0123

Conforms to the European Medical Device Directive (MDD)

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1 SYSTEM OVERVIEW

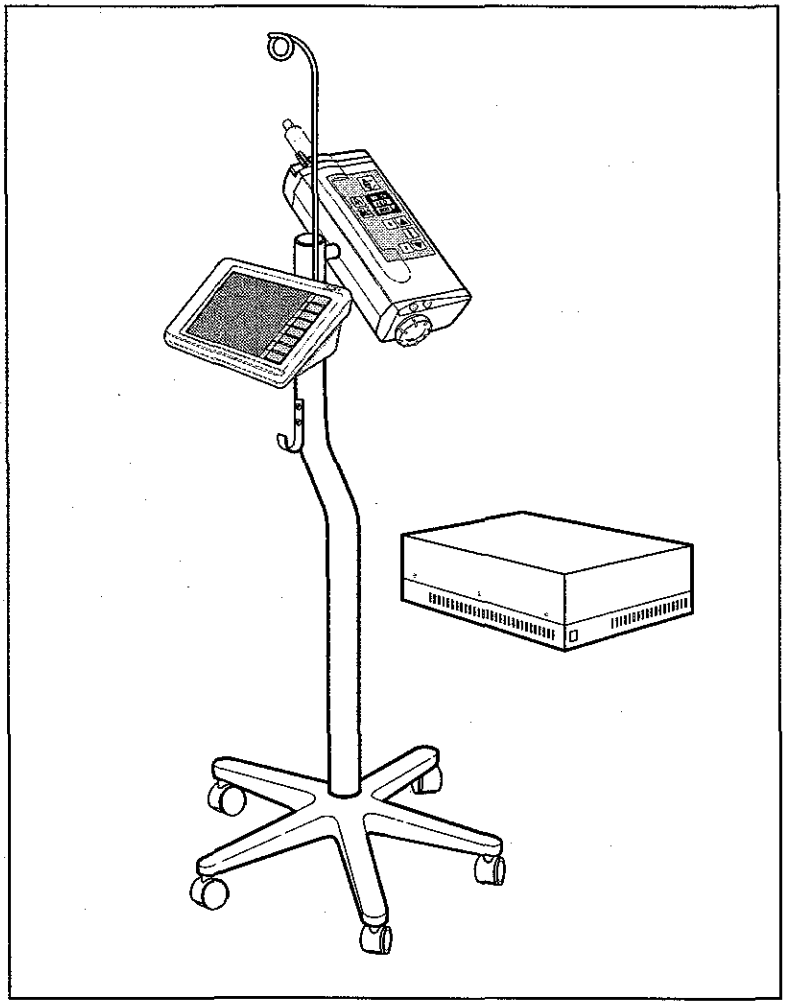


Figure 1-1. CT 9000 ADV Digital Injection System

The CT 9000 ADV Injector is designed to inject a radiopaque contrast medium into a patient's vascular system which enhances diagnostic images obtained with computed tomography (CT). Each injection is accomplished with a motor-driven syringe mechanism with microprocessor control of the flow rate, volume, and timing.

This manual provides service and calibration procedures for the CT 9000 ADV Injectors. For further information about operating and daily maintenance of the unit, refer to the CT 9000 ADV Operator's Manual.

SERVICE TECHNICIAN QUALIFICATION

The CT 9000 ADV Digital Injection System should be serviced and calibrated ONLY by qualified personnel who:

- are completely familiar with the unit
- have read and understood this manual and the Operator's Manual
- are properly trained in servicing equipment of this type.

Failure to follow these guidelines could result in serious injury to the service technician.

SPECIFICATIONS

DIMENSIONS

Control Console	12 W x 8.4 D x 4.2 H inches (30 W x 21 D x 10.4 H cm)
Powerhead	3.5 W x 16 D x 6 H inches (9 W x 41 D x 16 H cm)
Power Pack (i.e., Electronics Cabinet)	12 W x 14 D x 6.5 H inches (30.5 W x 35.5 D x 16.5 H cm)

WEIGHT

Standard System, complete	38 lbs (17.2 kg)
Control Console	7 lbs (3.2 kg)
Powerhead	18 lbs (8.1 kg)
Power Pack	13 lbs (5.9 kg)

POWER REQUIREMENTS

Standby	less than 1 A
Standard	115 VAC, 3 A, 50/60 Hz
	230 VAC, 1.5 A, 50/60 Hz

VOLTAGE REQUIREMENTS

Unit automatically adapts for input voltages from 100 to 240VAC.

ELECTRICAL LEAKAGE

Chassis	less than 300 microamps

ENVIRONMENTAL

CAUTION!
The console and electronics cabinet are not spill-proof. Fluid spilled in these components can cause the unit to malfunction, resulting in patient or operator injury. If fluid is spilled on either component, remove from operation and contact your authorized service personnel.

DANGER!
Possible explosion hazard if used in the presence of flammable anesthetics. The unit is not designed for use in explosive environments.

WARNING!
The powerhead may only be operated in an area that is located beyond the 20 gauss limit. Operating the unit within magnetic fields that are higher than this limit may cause the unit to malfunction, resulting in operator or patient injury.

SYRINGES

Syringe Sizes	200 ml (front-load)
	200 ml (pushrod)
	125 ml (pre-filled)
	100 ml (pushrod)
	50 ml (hand-held)
	30 ml (hand-held)

FILL RATE

Full forward or reverse time: 13-100 sec. Accelerates from zero to maximum within approximately 3 seconds after pressing the [Forward] or [Reverse] key in conjunction with one of the [Fast] keys.

SYRINGE HEATER

98° ± 6° F (37° ± 3° C) nominal. Maintains the temperature of pre-heated contrast. Overtemp condition will occur at 107.6° F (42° C).

NOTE: *The syringe heater for use with with the 200 ml (front-load) and 125 ml (pre-fill) type syringes with pressure sleeves is P/N 800114.*

The syringe heater for push and turn type faceplate is P/N 800146

FLOW RATE PARAMETERS

200 ml Syringes	0.1—9.9 ml/s
125 ml Syringe	0.1—9.9 ml/s
100 ml Syringe	0.1—9.9 ml/s
30-50 ml Syringe	0.1—7.0 ml/s

PRESSURE LIMIT

Pressure Units	Range
pounds per square inch (psi)	25, 50—300 (150*)
	(in 50 psi increments)
bar	2, 3, 7, 10*, 14, 17, 21
kg/cm^2	2, 4, 7, 11*, 14, 18, 21

NOTE: *(*) Used to denote pressure values pertaining only to the 200 ml pushrod syringe*

INJECT DELAY

Inject Delay Parameters	0—255 sec

SCAN DELAY

Scan Delay Parameters	0—99 sec

STORED PROTOCOLS

12 protocols can be stored and recalled.

2 INSTALLATION

UNPACKING AND ASSEMBLY PROCEDURES

When receiving the CT 9000 ADV Digital Injection system, first check the equipment for signs of damage. If any of the items are damaged or missing, don't accept the shipment until the freight or express agent notes the problem on the receipt or bill. If equipment is later discovered to be damaged or missing, notify the shipping agent within 15 days after receiving the items.

Store the equipment in the shipping cartons until ready for installation. The storage area should be clean and dry and should not subject the equipment to temperature extremes.

When unpacking the CT 9000 ADV, remember that it contains fragile electronic parts. Don't drop it or subject it to other mechanical shocks.

INSTALLATION PROCEDURE

Refer to the Checklist included in the front of this manual.

1. After unpacking, identify these parts of the system and record each component's Serial Number in the Installation Checklist:
   - ❑ Console
   - ❑ Power pack (Electronics Cabinet)
   - ❑ Powerhead
   - ❑ Printer and its associated hardware (optional)
   - ❑ Console to Power pack cable
   - ❑ Powerhead to Power pack cable
   - ❑ Power Cord
   - ❑ Ordered Accessories

2. *Inspect the exterior of the Console:*
   Check the Console Cable connector for cracks or bent pins.
   Check the Console case for dents or other external damage.

3. Inspect the exterior of the Power pack:
Check the Power pack cabinet for dents or scratches.
Check the connectors located on the rear of the cabinet for cracks or protruding pins.

4. Inspect the exterior of the Powerhead:
Check the cable for nicks or impairment due to crimping.
Check the Heater connector and the Powerhead Cable connector for cracks or bent pins.

5. Inspect the Console cable, the Powerhead cable and the Power Cord. Check each cable for nicks or impairment due to crimping.
Check the Power Cord for nicks or impairment due to crimping.

6. Inspect each Accessory to ensure there are no dents or scratches.

7. Mounting the Powerhead, Power pack and Console will depend on the type of accessories ordered. Refer to the Installation Instructions that accompanies the accessories in order to mount the components to your desired configuration.

8. Power must be off before connecting or disconnecting the system's cabling. Connecting cables after the Unit is powered may cause generation of false error messages. System connections are as follows:

ELECTRONICS CABINET

Remote Handswitch Connection

An 8-pin circular DIN connection allows for interfacing with an optional remote handswitch.

Printer Connection

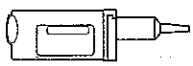
An 8-pin circular mini-DIN connection allows for interfacing with an optional printer.

Primary Console

A 15-pin D-shell connection sends and receives information to and from the Console.

Secondary Console

A second 15-pin D-shell connection sends and receives information to and from an optional second Console.



Powerhead Connection

A 25-pin D-shell connection sends and receives information to and from the powerhead.

Power Cord Connection

The supplied power cord connects to the Electronics Cabinet at the power connection. The unit can accept either 115 VAC (50/60 Hz) or 220 VAC (50/60 Hz) without modification. The unit will automatically sense the input voltage during power-up sequences.

CAUTION!

Use only the supplied power cord to connect power to the Power Cord Connection. Use of other power cords could result in damage to the equipment. Units installed outside of the U.S. must use hospital approved power cords.

POWERHEAD

Heater Blanket Connection

A 4-pin connection, located on the bottom of the Powerhead, sends and receives information to and from the Heater Blanket.

ELECTRONICS CABINET CONNECTION

A 25-pin connection, located on the bottom of the Powerhead, sends and receives information to and from the Electronics Cabinet.

CONSOLE

Electronics Cabinet Connection

A 15-pin connection, located on the rear of the console, sends and receives information to and from the Electronics Cabinet.

9. Install the Pressure Plate Assembly. Instructions covering installation of the Pressure Plate Assembly are contained in the Operator's Manual, P/N 800731, or 800959 international.

10. Perform the Preventive Maintenance Checks listed in Chapter 6. If all requirements for these tests are passed, then proceed to the next section.

TURN ON THE CT 9000 ADV

Turn the unit on by first toggling the Power pack's Power Switch located on the rear of the cabinet and then pushing the Console power switch located on the left-hand side of the console. The LED located on the Power pack and on the upper right-hand corner of the console will glow and the Start-up Menu will be displayed.

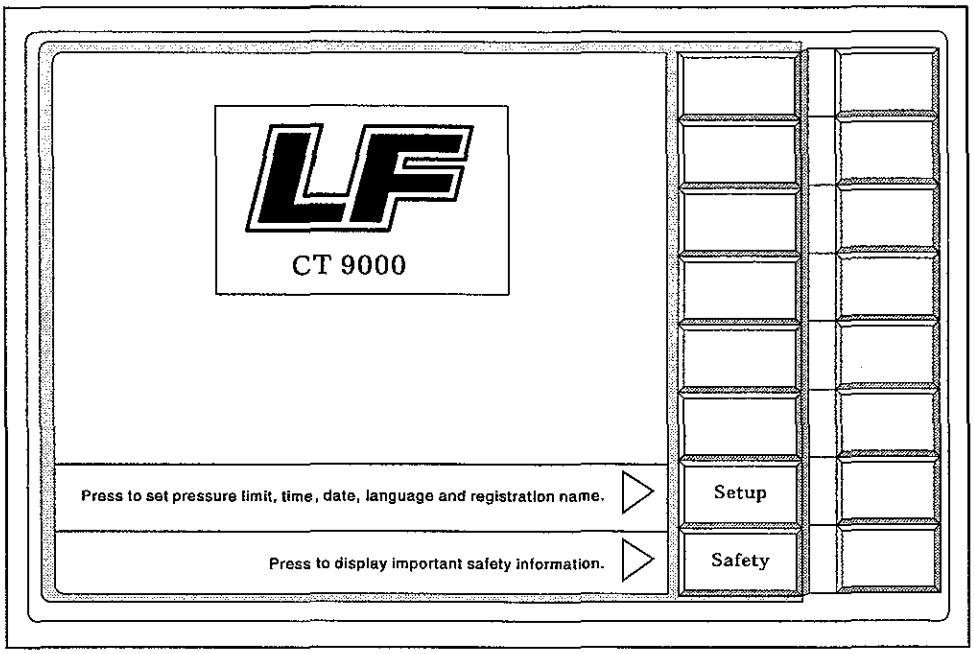

CT 9000
Press to set pressure limit, time, date, language and registration name.
Setup
Press to display important safety information.
Safety

Figure 2-1. Start-up Menu

RECORD THE VERSION LEVEL

Press the [Safety] key, then the [Version] key. Record the firmware version level of each component in the Installation Checklist. Press the [Exit] key.

ENTER THE PRESSURE LIMIT, TIME, DATE, LANGUAGE AND REGISTRATION NAME

Press the [Setup] key and enter the required Pressure Limit, Time, Date, Language and Registration Name. Instructions on entering these items are contained in the Operator's Manual, P/N 800959.

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POWER PACK OVERVIEW

The power pack consists of three major functional sections. First is the MAIN POWER INPUT, second is the MOTHERBOARD and third is the CPU BOARD. Figure 3-2 below shows a block diagram of these sections.

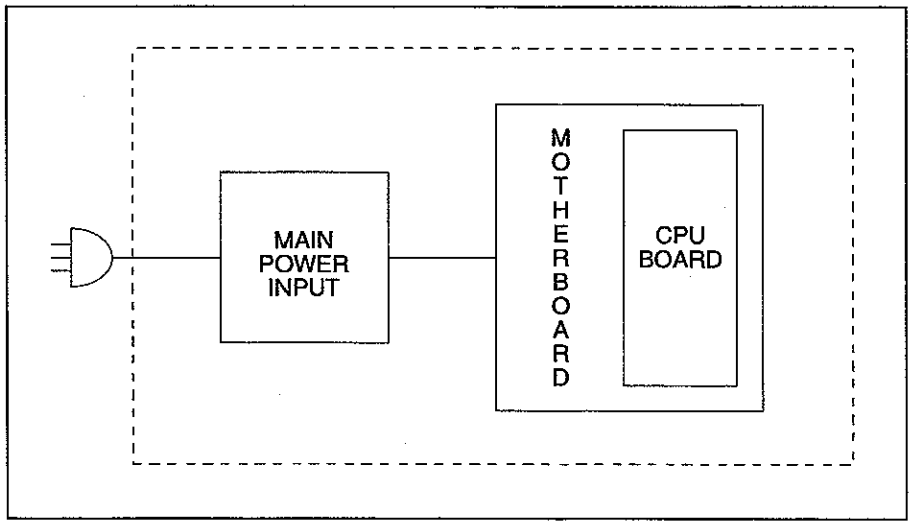

Figure 3-2. Power Pack Overview

MAIN POWER INPUT

The line voltage enters the Power Pack through an IEC 320 power inlet. As shown in Figure 3-3, the power inlet is wired to a 3 amp, double pole, double throw circuit breaker. The circuit breaker output is connected to a line filter. The chassis ground of the power inlet and the line filter are connected to the frame. The filtered line voltage is input to the VOLTAGE SELECT board. The VOLTAGE SELECT board, which is actually mounted on the main power transformer, senses the line voltage and configures the main power transformer's primary winding so that the secondary output is 24VAC. A complete description of this boards operation is given below.

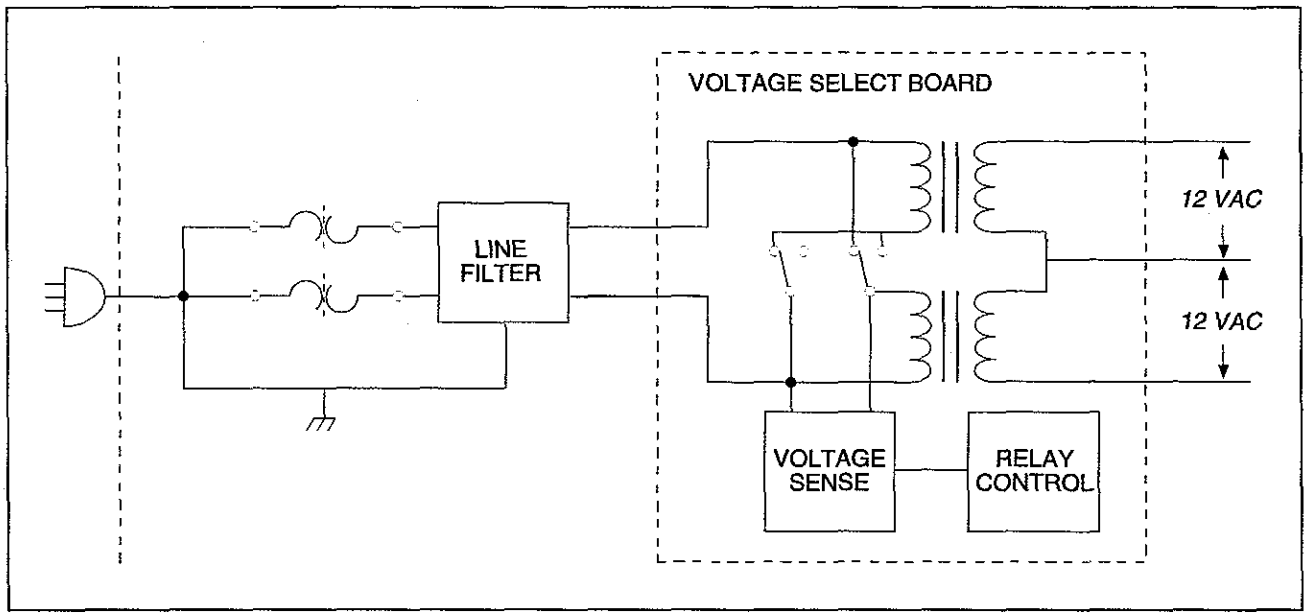

Figure 3-3. Main Power Input

VOLTAGE SELECT BOARD

As mentioned above, the VOLTAGE SELECT board is responsible for sensing the line voltage and configuring the main power transformer's primary winding. The sensing circuit samples the transformer's center tap to keep the circuit's input at 115VAC. Resistor R1, and varistor MOV1 prevent transient voltages from tripping the circuit.

The bridge rectifier—BR1, R2, DZ1 and C2—powers the circuit and provides base drive for transistor Q2. The dc voltage from the bridge rectifier varies with the input AC voltage.

The MC34064 under-voltage sensor, U1, trips at 4.6V. Note that U1's RESET pin is an output, not an input; the chip's intended function is resetting µP systems. When the rectified line voltage is below U1's trip point, RESET is low, which sets up R3 and R4 as a voltage divider.

When the input voltage goes above 4.6V, U1 trips, setting the RESET output high. RESET's going high turns on Q2, which energizes relay K1. K1 re-configures the transformer's primary for 220V. This trip point will occur at approximately 155V. To prevent relay K1 from oscillating or "hunting," resistor R4 adds hysteresis to U1's operation. Once the primary is configured for 220V, the line voltage must fall to approximately 75V before the transformer's primary will be re-configured to 115V.

Relay K1 cannot handle the large transient voltages that sometimes occur around the switching point. Transistor Q1 and resistor R7 limit current through K1 to 10 ma.

MOTHERBOARD

The MOTHERBOARD consists of the following major components, each of which will be discussed in greater detail in the following sections:

- Power Supplies
- Powerhead Interface
- Servo
- Auxiliary I/O Interface
- Handswitch Interface
- Status LED's
- Console Connectors

Power Supplies

The power supply section consists of four major functional sections: Remote on/off, +3.5V supply, +5V supply and +12V supply.

Remote On/Off

The main power transformer supplies 24VAC to the motherboard. One side of the 24VAC goes directly to a diode bridge, BR1. The other side of the 24VAC goes through a solid state relay, SSR1, and then to the diode bridge. The solid state relay is controlled by U17. When the solid state relay is off, the 24VAC is not applied to both sides of the bridge and, therefore, the +5V and +12V supplies are off. However, U17 requires power to operate the remote on/off function, so the +3.5V supply is used to power U17 while the +5V and +12V supplies are off.

The Power Supply Control Input (/PSI, U17 pin 8) and Power Supply Control Output (/PSO, U17 pin 16) are used to control the solid state relay. Prior to establishing a voltage on VCC (U17 pin 3), PSI is internally held at a high level at all times by the +3.5V supply on VBAT (U17 pin 1). When /PSI is forced low by the motherboard reset switch, SW1, or by the momentary switch on a console, PSO is connected to VBAT to provide a high level. This high level turns on the solid state relay. A subsequent falling edge on /PSI will tristate PSO to shut off the solid state relay.

Relay K3 is used to isolate +5V from U17 pin 3 until the solid state relay turns on. This, along with a filter formed by L3 and C34, helps to eliminate noise related problems.

Opto-isolator U18 is used to interface /PSI to the console switches and the motherboard switch, SW1. Capacitor C8 is placed across the LED side of U18 to prevent it from inadvertently turning on when a long console cable is attached.

+3.5V Supply

The +3.5V supply is used to supply power to U17 when the +5V supply is off. It also powers the LED located on the front of the Power Pack.

The adjustable regulator VR3 is supplied +14V unregulated DC by rectifying (D3 and 1/4 of BR1) and filtering (C9) the main transformer secondary center tap voltage. VR3's output voltage is set as follows:

$$Vout = 1.25V\ (1 + R13/R14) = 1.25V(1 + 1500/680) = 4V$$

This +4V is dropped to approximately 3.5V by D13 before being connected to U17 pin 1.

+5V Supply

The +5V supply is used to power the MOTHERBOARD logic circuitry and the CPU board. The +5V regulator is a step down DC to DC converter capable of sourcing up to 5A of output current.

At intervals of approximately 10µs (100kHz) VR2 connects VR2-5 to VR2-4 impressing a voltage across inductor L2. This causes current to build up in the inductor while also supplying current to the load and filter capacitor C4.

VR2 determines when to disconnect VR2-5 and VR2-4 during the 10µs interval to keep the output voltage at +5V. When VR2-5 and VR2-4 are disconnected, the magnetic field in the inductor collapses and the polarity of the voltage across the inductor changes to try and maintain the current in the inductor. This current in the inductor is now directed (due to the change in voltage polarity across the inductor) by the diode D2, to the load. The current will flow from the inductor until the switch turns on again or until the inductor runs out of energy.

The divider circuit of R6 and R5 is used to set the output voltage of the supply against an internal voltage reference of 2.21VDC. The output voltage is calculated as follows:

$$Vout = 2.21V\ (1 + R6/R5) = 2.21V(1 + 2870/2210) = 5.08V$$

R4 and C5 make up the frequency compensation network used to stabilize the feedback loop.

+12V Supply

The +12V supply is supplied to the MOTHERBOARD, the CPU board and is used as the bulk supply for the POWERHEAD board. The +12V regulator is identical to the +5V regulator with the exception of the divider circuit which sets the output voltage. The output voltage for the +12V supply is calculated as follows:

$$Vout = 2.21V\ (1 + R3/R2) = 2.21V(1 + 9760/2210) = 11.97V$$

Powerhead Interface

The powerhead interface provides the interface between the powerhead DB-25 connector and the CPU board. The pin out for the powerhead DB-25 connector is given in Table 3-1.

RS-422 transmitter U4 pin 9 translates serial communications (TXDB) from the CPU board for transmission to the POWERHEAD. RS-422 receiver U13 pin 11 translates the RS-422 serial communications (RXDB) and motor encoder quadrature pulses transmitted from the POWERHEAD board to the CPU board. The motor encoder quadrature pulses are input to J-K flip flop U14 pin 3 and 4 to generate a motor direction signal to the CPU board. A high on U14 pin 6 indicates the motor is expelling. A low on U14 pin 6 indicates that the motor is filling.

The serial communications between the POWERHEAD and CPU boards are combined by U6 pin 6 and converted to RS-422 by U4 pin 15. The resulting signal is output to connector J13 and may be used to monitor powerhead communications.

Table 3-1. Powerhead DB-25 Pin Designations

J5 Pin	Signal Name	Signal Description
1	CHGND	Chassis GND
2	MOTPWR-	Motor power
3	MOTPWR-	Motor power
4	MOTPWR-	Motor power
5	MOTPWR+	Motor power
6	MOTPWR+	Motor power
7	MOTPWR+	Motor power
8	GND	Signal GND
9	GND	Signal GND
10	GND	Signal GND
11	CHGND	Chassis GND
12	CHGND	Chassis GND
13	RCV+	Head data receive+
14	+12V	Logic power
15	+12V	Logic power
16	+12V	Logic power
17	ENCTRL	ENABLED lamp control
18	INJCTRL	INJECTING lamp control
19	TXD+	Head data transmit +
20	TXD-	Head data transmit -
21	ENCB-	Motor encoder phase B -
22	ENCA-	Motor encoder phase A -
23	ENCA+	Motor encoder phase A +
24	ENCB+	Motor encoder phase B +
25	RCV-	Head data receive -

Servo

The servo section of the motherboard is concerned with generating the motor power, stopping the motor, sensing pressure and hardware safety features. Each topic will be covered separately.

Motor Power

Motor power is generated by a flyback regulator circuit. Flyback regulators (Figure 3-4) use a transformer to transfer energy from input to output. During S1 "on" time, energy builds up in the core due to increasing current in the primary winding. At this time, the polarity of the output winding is such that D1 is reverse biased. When S1 opens, the total stored energy is transferred to the secondary winding and current is delivered to the load. This circuit provides isolation and safety. If S1 shorts out, no voltage is generated on the secondary and the motor will not move.

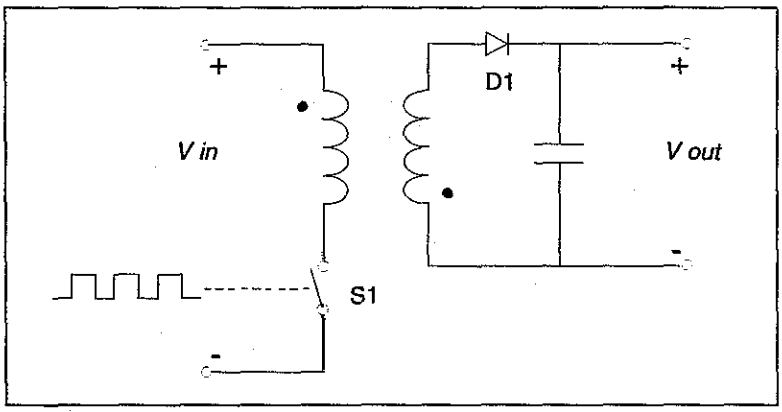

Figure 3-4. Typical Flyback Regulator Circuit

The main components of the flyback regulator circuit on the MOTHERBOARD consist of T1, Q4, D5, C11 and U16. An analog voltage from the CPU board is input to PWM (Pulse Width Modulator) IC U16 pin 2. This IC converts a 0 to +5V analog voltage to a 0 to +10V PWM output signal on IC U16 pin 14. The PWM signal is characterized by a 100kHz frequency and a 0 to 50% duty cycle. C14 and the potentiometer R80 set the PWM frequency using the following formula:

$$f = 1 / 2 (C14 (0.7R80))$$

The potentiometer R80 (R27 on boards 800906 Rev G and earlier) is preset at the factory to generate a 100kHz frequency. The PWM output, U16 pin 14, controls FET Q4. This FET acts as the switch in the flyback regulator circuit shown in Figure 3-4. T1 transfers energy from input to output. During the FET "on" time (i.e. gate voltage = 10V), energy builds up in the core. During the FET "off" time (i.e. gate voltage = 0V), the total stored energy is transferred to the secondary winding and current is delivered to the load.

Flyback converters require a clamp to protect the FET switch from overvoltage spikes when it opens. These spikes are caused by leakage inductance in the transformer. D7, R23 and C12 form a voltage clamp which limits the voltage spikes from exceeding the BVDSS rating of Q4.

Capacitor C11 smooths out the ripple to provide a DC voltage to the motor. The motor voltage is routed through relay K1 which controls the direction of the motor movement. When the relay is off, the motor will expel; when the relay is on, the motor will fill.

Stopping

The motor can be braked by either shorting the motor leads together, shorting the output of the flyback transformer, T1, or by setting the STOP pin on U16 pin 10 high.

When the SAFE RELAY K2 is off, any voltage impressed on the motor will turn on triac Q1 which shorts the motor leads together. In order for the motor to move, therefore, it is necessary to turn the SAFE RELAY on. To turn on the SAFE RELAY it is necessary to set the SAFE RELAY CTL line (U6 pin 9) high and to toggle the watchdog fail-safe (U17 pin 11) at least once every 170 ms. This sets the fail-safe line (U6 pin 10) high.

The output of the flyback transformer is shorted by the brake circuit consisting of Q2, Q3, R20-R22. If U15 pin 16 is low the gate of Q2 is low, so it is "off". If U15 pin 16 is high the gate of Q2 is high, Q2 turns on and the output of the servo transformer is shorted. Motor current flowing through Q2 generates a voltage across R21. If excessive current flows through Q2 the voltage across R21 will rise high enough to turn on Q3. When Q3 turns on, Q2 is turned off thus preventing excessive current from damaging Q2. When the DEAD STOP signal from the CPU is high and if either SIGN or INJECT are high (but not both), U15 pin 16 is low (i.e. brake is off).

When the PWM STP STATUS line (U16 pin 10) is high the PWM output (U16 pin 14) is held low and, therefore, FET Q4 is kept off. The PWM STP STATUS line is high under the following conditions: U17 pin 11 is not toggled within 170 ms (this causes fail safe U14 pin 10 to go low), DEAD STOP is low, PRESSURE LIMIT 3 is low, either SIGN and INJECT are high, but not both.

The following table lists the signal status required to run the motor:

Table 3-2. Motor Signals

Signal Name	Status Required To Run The Motor
PWM CONTROL	> ~ 0.5V
DEAD STOP	+5V
SIGN	0v (expel), +5V (fill)
INJECT	+5V (expel), 0V (fill)
FAILSAFE	+5V
PRESSURE LIMIT 3	+5V
SAFE RELAY CTL	+5V

Pressure Sensing and Control

Motor current is run through a sensing resistor which generates a voltage that is proportional to the pressure. This voltage is then amplified to a usable level and input to both the A/D located on the CPU board and a hardware pressure limit circuit located on the motherboard.

There are actually two pressure sensing circuits. One is located on the primary side of the servo transformer, T1, the second is located on the secondary side of the servo transformer. The two circuits are identical with the exception of some resistor values. The following discussion will refer to the pressure sensing circuit on the secondary side of T1.

When the motor is running, current flows through R19. The voltage developed across R19 is amplified by two separate operational amplifier circuits. The first circuit consists of U9, R33 and R36. The output of U9 pin 1 is input to the A/D, U16 pin 2, located on the CPU board and into one side of a comparator, U10 pin 4. The output of the comparator is input to the CPU board. The second circuit consists of U9, R31 and R35. The output of U9 pin 7 is input to one side of a comparator, U10 pin 6. The output of this comparator is input to the PWM control circuitry. This circuit is referred to as the hardware pressure limit control.

The other inputs of the comparators, Level 1 and Level 2, in these two circuits are set to a level corresponding to the current pressure limit value. This value is determined during pressure calibration and is set by the digital potentiometer, U8. When the pressure sensed exceeds the pressure limit value two actions occur. First the hardware pressure limit control will turn off the PWM control, thereby reducing the power output to the motor and reducing pressure. Second, the CPU board is notified through the comparator output and the A/D that a pressure limit condition has occurred.

For example, assume that the pressure limit is set to 200 psi and an injection is enabled. Assume that during pressure calibration it was determined that at 200 psi the gained up voltage level equals 1.5V. The digital potentiometer, U8, will output 1.5V to the two comparators used for pressure limit detection on the secondary side of the servo transformer, U10 pin 5 and U10 pin 7. Assume the injection starts and the pressure approaches 200 psi. When 200 psi is exceeded, the gained up voltage from the sense resistor R19 will exceed 1.5V. At this point the hardware pressure limit comparator will go low thereby disabling the PWM controller, U16. In addition, the 1.5V is sensed by the A/D on the CPU board and the comparator input to the CPU board also goes low.

The hardware pressure limit circuitry provides the primary pressure limit control with the software providing the backup pressure limit function. A circuit similar to the circuitry that provides information to the CPU board (i.e. gained up voltage level and pressure limit comparator output) from the secondary side of the servo transformer also exists on the primary side of the servo transformer. This circuitry is not currently used for pressure limit control.

Auxiliary I/O Interface

The auxiliary I/O interface provides the RS-422 interface between an external device and the CPU board. U4 pin 1 is used to translate the serial communications transmitted from the CPU board to the external device to RS-422 levels. U13 pin 3 is used to translate RS-422 serial communications from the external device to the CPU board.

An RS-232 device can be connected to this port by connecting the minus output of U4 (U4 pin 3) to the external device receive line. The auxiliary I/O connector pinout is shown in Table 3-3.

Table 3-3. Auxiliary I/O Connector Pinout

J5 Pin	Signal Name
1	Not Used
2	Not Used
3	RCV-
4	GND
5	TXD-
6	RCV+
7	Not Used
8	TXD+

Handswitch Interface

The handswitch interface connects the remote start handswitch to the CPU board. +12V is supplied to the handswitch connector, J1. Four identical isolated inputs are also connected to J1. Two of the isolated inputs are used for the handswitch and two are spare.

The isolated input circuit consists of a current limiting resistor (RN3) connected to the LED side of an opto-isolator (U1, U2). The output of the opto-isolator is pulled high by RN7 and input to inverter U3. The remote handswitch uses a double action switch to connect +12V to the isolated inputs. This is done as a safety feature to eliminate a single fault failure from initiating an injection. The software has to see both handswitch inputs open and then closed in order to start an injection.

The handswitch connector pinout is shown in Table 3-4.

Table 3-4. Handswitch Connector Pinout

J5 Pin	Signal Name
1	Spare in 2
2	+12V
3	Handswitch in 1
4	+12V
5	+12V
6	Chassis GND
7	Handswitch in 2
8	Spare in 1

Status LED's

Ten status LED's are supplied on the MOTHERBOARD. These LED's are described in Table 3-5.

Table 3-5. Motherboard Status LED's

LED#	NAME	LED ON	LED OFF
1	Servo Power Voltage	Servo power supply on	Servo power supply off
2	+12V	+12V supply on	+12V supply off
3	+5V	+5V supply on	+5V supply off
4	Dead Stop	PWM stop off	PWM stop on
5	Brake	Brake is on	Brake is off
6	Pressure Limit 1	No pressure limit	Pressure limit
7	Direction	Motor moving foward (expel)	Motor moving reverse (fill)
8	Safe Relay	Safe relay is off	Safe relay is on
9	Pressure Limit 3	No pressure limit	Pressure limit
10	Pressure Limit 2	No pressure limit	Pressure limit

Mother Board BUS Connectors

The 64-pin EuroDIN connectors that make up the Motherboard bus (J6, J7, J8, K11, K10, K9) are designed to provide 3 identical slots for plug-in boards (i.e. CPU board). The 3 slots are configured as follows:

Table 3-6. Mother Board Slot Configuration

Slot	Configuration
1	J6, K11
2	J7, K10
3	J8, K9

Several pins on these connectors are used for CPU control of the Motherboard. Refer to the CPU board Theory of Operation for a complete listing of these pins.

Console Connectors

The DB-15 connectors for the two consoles are located on the MOTHERBOARD. These connectors are connected straight through to the CPU board. Filtering (EF3-EF6) is provided on the transmit lines. The console cable pinout is shown in Table 3-7.

Table 3-7. LCD Module Interface Connector

J3 & J4 Pin	Signal Name
1	Chassis GND
2	HALT+
3	HALT-
4	TXD+
5	TXD-
6	Not Used
7	RCV+
8	RCV-
9	REMOTE ON/OFF
10	Chassis GND
11	Chassis GND
12	+VDC
13	+VDC
14	GND
15	GND

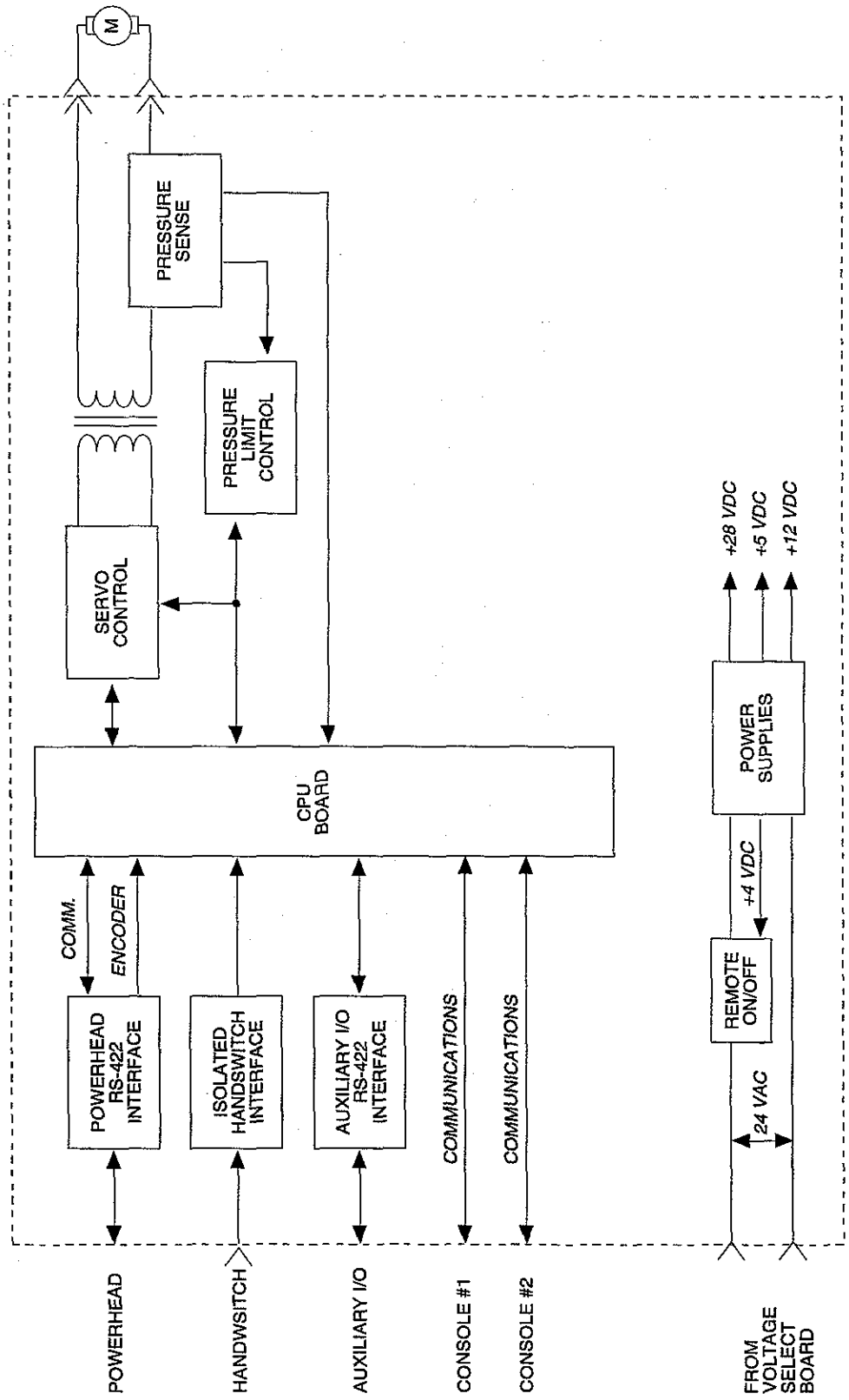

Figure 3-5. Motherboard Block Diagram

CPU BOARD

The CPU board consists of the following major components, each of which will be discussed in greater detail in the following sections:

- Microcontroller
- Data Communications
- Digital to Analog converter
- Analog to Digital converter
- EEPROM
- RAM
- ROM

Power Up

When power is applied to the microprocessor, U4, a reset controller, U8, generates a low pulse on the microprocessor RESET line. The reset pulse must be at least 35µs to ensure a proper reset.

A diode, D19, is tied between data line D0 and the RESET pin so that D0 is pulled low when RESET goes low. This configures the port size of the CSBOOT chip select to 8 bits. This is necessary because CSBOOT is connected to an EPROM, U10, that has an 8-bit wide data bus.

After initial power up the system may be reset by pressing the reset push-button, PB1.

Microprocessor Configuration and Operation

The microprocessor uses a 32.768 kHz crystal, X1 as a reference frequency source for an on-chip phase-locked loop which generates the 16.76 MHz clock speed.

The 16 external data lines (D0-D15) are buffered by two 8-bit 3-state non-inverting bus transceivers (U2, U3). The direction of data flow is controlled by the unbuffered R/W line U4 pin 79.

All the chip select lines (CSBOOT-CS10), the R/W line and 17 of the 19 external address lines (A0-A16) are also buffered by 8-bit 3-state non-inverting bus transceivers (U1, U5, U6, U7).

DUART Configuration and Operation

Each DUART (U13, U14) provides two fully independent full duplex asynchronous communications channels, six input lines, and eight outputs lines.

The following discussion will refer to DUART U14. The clock input is supplied by buffering the X1/CLK pin of DUART U13 with a 74HC14, U9. The six input lines are connected to a dip switch, SW1. Pull ups R7-R11 are provided so that the input is high if the switch is open and low if the switch is closed. Four of the eight

output lines (OP1, OP3-OP5) are used to control LED's. A high on these outputs will drive the output of the 74LS05, U11, low, thereby pulling current through the current limiting resistors, R13-R16, and the LED's, LED1-LED4. Output OP6 provides on/off control for the RS-422 line driver, U20. Output OP7 provides on/off control for the RS-422 line receiver, U19. LED1-LED4 are for programming and are not used for data during normal operation.

The interrupt line for DUART U14 is connected to IRQ5 on the microprocessor and the chip select is connected to CS8 on the microprocessor.

The transmit outputs of U14 are connected to a 34C87, U20 pin 9 and 15, which is a quad RS-422 line driver. The outputs of each driver has a 10ý series resistor and an EMI filter on each differential output. As mentioned above, on/off control for this chip is provided by OP6. The receive inputs are connected to a 34C86, U19 pin 3 and 5, which is a quad RS-422 line receiver. A 220ý resistor is placed across the differential inputs. As mentioned above, on/off control for this chip is provided by OP7.

The following discussion will refer to DUART U13. All 6 input lines (IP0-IP5) all 8 output lines (OP0-OP7) and both pairs of receive and transmit lines are output to connector K1, K9, K10, K11.

A 3.6864 MHz crystal (X2) is used by U13 to generate standard bit rates.

The interrupt line for DUART U13 is connected to IRQ6 on the microprocessor and the chip select is connected to CS6 on the microprocessor.

Auxiliary RS-422 Inputs

Two line receivers U19 pins 1 and 13 are used both as inputs to a microprocessor I/O pin and as input to IRQ7, the non-maskable interrupt. The output of the two line receivers are input to an RC network—R45, C29 and R46, C30—and then to open collector inverters, U11. When the output of the line receiver goes low the RC network generates a pulse into the open collector inverter. This prevents the NMI line from bouncing and from staying low indefinitely. The output of these two open collector gates are then tied together, pulled up by RN5 and input to IRQ7.

EEPROM Operation

The EEPROM (U17) is socketed so that either an 8K x 8-bit or 32K x 8-bit EEPROM can be used. No modification is necessary to move from one size to the other.

The R/W line is inverted by U9 pin 6 to generate the EEPROM output enable (OE).

RAM Operation

The RAM (U15) is socketed so that it can handle any JEDEC standard 32K x 8-bit, 64K x 8-bit or 128K x 8-bit RAM. The socket will be 32-pin to accommodate the 128K x 8-bit device. If a smaller (28-pin) RAM is used it should use the lower portion of the socket (i.e. pin 1 of the device = pin 3 of the socket). Note that the chip select line is tied to the output enable line, which means that the outputs will be enabled for both reads and writes. However, during a write operation, the output enable is a "don't care" input.

EPROM Operation

Any JEDEC standard 64K x 8-bit or 128K x 8-bit EPROM may be used in the sockets occupied by U10 and U12. The CPU system will boot from EPROM U10. Therefore, if only one EPROM is used, it must be placed in U10.

Digital to Analog Converter Operation

U18 is the Digital to Analog Converter (DAC) chip. It is a 12-bit DAC with a full 12-bit interface to the microprocessor.

An RC network (R37, C21, C9) is connected to the REFOUT pin in order to provide decoupling for the internal voltage reference.

The DAC uses a +12 V supply. This is the only chip on the CPU board that uses +12 V. The output range is jumper configurable as 0 to +5 V or 0 to +10 V. It is hardwired for 0 to +5 V. The output code is natural binary with 1 LSB defined as follows:

For 0 V to +10 V Range: $1\ LSB = V_{REF}(1/2048) = 2.44\ mV$

For 0 V to +5 V Range: $1\ LSB = V_{REF}(1/4096) = 1.22\ mV$

Analog to Digital Converter Operation

U16 is the Analog to Digital Converter (ADC) chip. It is an 8-channel, 8-bit ADC. The microprocessor uses the Serial Peripheral Interface (SPI) bus to communicate with the DAC.

The input range is 0 to +5 V. The inputs are protected by 4.7 kÝ resistors (R24-R30, R36).

The output code is natural binary with 1 LSB defined as follows:

$$1\ LSB = FS/256 = (5/256)V = 19.5\ mV$$

A conversion is started when the microprocessor reads one of the eight channels. When the INT line goes low an interrupt is generated on microprocessor IRQ3. Another read of the same channel will contain valid conversion data.

Jumpers and LED's

Jumpers and LED's are for Liebel-Flarsheim testing use only.

Hardware Summary

Table 3-8 contains a summary of the hardware connections for the significant integrated circuits on the CT 9000 ADV CPU board.

Table 3-8. CT 9000 ADV CPU Board Hardware Summary

U#	Description	Data Lines	Address Lines	Chip Select	IRQ
10	EPROM-Prog.	DB8-DB15	A0-A16	BOOT	-
12	EPROM-Lang.	DB8-DB15	A0-A16	10	-
13	UART	DB8-DB15	A0-A3	6	6
14	UART	DB8-DB15	A0-A3	8	5
15	RAM	DB8-DB15	A0-A16	9	-
16	ADC	-	-	-	3
17	EEPROM	DB8-DB15	A0-A14	3	-
18	DAC	DB0-DB11	-	5	-

Input/Output Definition

There are 128 signal lines contained on the two Euro-DIN connectors that connect the CPU board to the Motherboard. The following table describes those signals:

Table 3-9. CPU Board to Motherboard, Pins J1A thru J5C

Pin#	Signal	CPU Board Description	Motherboard Usage
J1A	BD0	Buffered data bus line 0	Not used
J1C	BD1	Buffered data bus line 1	Not used
J2A	BD2	Buffered data bus line 2	Not used
J2C	BD3	Buffered data bus line 3	Not used
J3A	BD4	Buffered data bus line 4	Not used
J3C	BD5	Buffered data bus line 5	Not used
J4A	BD6	Buffered data bus line 6	Not used
J4C	BD7	Buffered data bus line 7	Not used
J5A	BD8	Buffered data bus line 8	Not used
J5C	BD9	Buffered data bus line 9	Not used

Table 3-9. CPU Board to Motherboard, Pins J6A thru J20C

Pin#	Signal	CPU Board Description	Motherboard Usage
J6A	BD10	Buffered data bus line 10	Not used
J6C	BD11	Buffered data bus line 11	Not used
J7A	BD12	Buffered data bus line 12	Not used
J7C	BD13	Buffered data bus line 13	Not used
J8A	BD14	Buffered data bus line 14	Not used
J8C	BD15	Buffered data bus line 15	Not used
J9A	RESET	MC68332 reset	Not used
J9C	Not used	Not used	Not used
J10A	TPU2	TPU Channel 2	Motor Channel A Encoder
J10C	TPU3	TPU Channel 3	Safe Relay Status
J11A	TPU4	TPU Channel 4	Handswitch Start 1
J11C	TPU5	TPU Channel 5	Handswitch Start 2
J12A	TPU6	TPU Channel 6	Handswitch Spare 2
J12C	TPU7	TPU Channel 7	Handswitch Spar 1
J13A	TPU8	TPU Channel 8	Motor Channel B Encoder
J13C	TPU9	TPU Channel 9	Motor Channel A Encoder
J14A	Not used	Not used	Not used
J14C	TPU10	TPU Channel 10	Motor Direction
J15A	TPU11	TPU Channel 11	Pressure Limit 3
J15C	Not used	Not used	Not used
J16A	Not used	Not used	Not used
J16C	TPU12	TPU Channel 12	Inject Lamp Control
J17A	TPU13	TPU Channel 13	Pressure Limit 2
J17C	TPU14	TPU Channel14	Safe Relay Control
J18A	TPU15	TPU Channel 15	Reverse Enable
J18C	TXD	Not used	MC68332 Transmit
J19A	RXD	Not used	MC68332 Receive
J19C	PCS2	SPI Chip Select 2	Not used
J20A	PCS1	SPI Chip Select 1	Not used
J20C	PCS3	SPI Chip Select 3	Not used

Table 3-9. CPU Board to Motherboard, Pins J21A thru K2C

Pin#	Signal	CPU Board Description	Motherboard Usage
J21A	PCS0	SPI Chip Select 0	Not used
J21C	SCK	SPI Serial Clock	Not used
J22A	MOSI	SPI Master Out Slave in data	Not used
J22C	MISO	SPI Master in Slave Out data	Not used
J23A	BA18	Buffered Address Line 18	Not used
J23C	BA17	Buffered Address Line 17	Not used
J24A	BA0	Buffered Address Line 0	Not used
J24C	BA1	Buffered Address Line 1	Not used
J25A	BA2	Buffered Address Line 2	Not used
J25C	BA3	Buffered Address Line 3	Not used
J26A	BA4	Buffered Address Line 4	Not used
J26C	BA5	Buffered Address Line 5	Not used
J27A	BA6	Buffered Address Line 6	Not used
J27C	BA7	Buffered Address Line 7	Not used
J28A	BA8	Buffered Address Line 8	Not used
J28C	BA9	Buffered Address Line 9	Not used
J29A	BA10	Buffered Address Line 10	Not used
J29C	BA11	Buffered Address Line 11	Not used
J30A	BA12	Buffered Address Line 12	Not used
J30C	BA13	Buffered Address Line 13	Not used
J31A	BA14	Buffered Address Line 14	Not used
J31C	BA15	Buffered Address Line 15	Not used
J32A	R/W	Buffered Read/Write line	Not used
J32C	BA16	Buffered Address Line 16	Not used
K1A	RMC	MC68332 Interrupt Request 3	Not used
K1C	RMC	MC68332 Read Modify Write Cycle	Not used
K2A	Not used	Not used	Not used
K2C	DSACK1	Data and Size Acknowledge 1	Direction Status

Table 3-9. CPU Board to Motherboard, Pins K3A thru K17C

Pin#	Signal	CPU Board Description	Motherboard Usage
K3A	CS0	MC68332 Chip Select 0	Not used
K3C	DSACK2	Data and Size Acknowledge 2	Pressure Limit 1
K4A	DS	Data Strobe	Not used
K4C	AS	Address Strobe	Not used
K5A	SIZ0	Size 0	Brake Status
K5C	SIZ1	Size 1	Not used
K6A	IRQ1	MC68332 Interrupt Request 1	Not used
K6C	IRQ2	MC68332 Interrupt Request 2	Not used
K7A	IRQ4	MC68332 Interrupt Request 4	Not used
K7C	IRQ7	MC68332 Interrupt Request 7 (NMI)	Power Fail
K8A	IP2-1	Input 2 on U13	Not used
K8C	IP5-1	Input 5 on U13	Not used
K9A	RXDA	Receive Channel A on U13	Auxiliary I/O Receive
K9C	TXDA	Transmit Channel A on U13	Auxiliary I/O Transmit
K10A	OP0-1	Output 0 on U13	Dead Stop
K10C	OP2-1	Output 2 on U13	Not used
K11A	OP4-1	Output 4 on U13	Not used
K11C	OP6-1	Output 6 on U13	Not used
K12A	OP7-1	Output 7 on U13	Not used
K12C	OP5-1	Output 5 on U13	Not used
K13A	OP3-1	Output 3 on U13	Watchdog
K13C	OP1-1	Output 1 on U13	Enable Lamp Control
K14A	TXDB	Transmit Channel B on U13	Power Head Transmit
K14C	RXDB	Transmit Channel B on U13	Power Head Receive
K15A	IP4-1	Input 4 on U13	Not used
K15C	IP1-1	Input 1 on U13	Not used
K16A	IP0-1	Input 0 on U13	PWM Stop Status
K16C	IP3-1	Input 3 on U13	Not used
K17A	OP2-2	Output 2 on U14	Not used
K17C	OP0-2	Output 0 on U14	Not used

Table 3-9. CPU Board to Motherboard, Pins K18A thru K32C

Pin#	Signal	CPU Board Description	Motherboard Usage
K18A	CH1	A/D Channel 1	Pressure Limit 1 A/D Channel
K18C	CH3	A/D Channel 2	Pressure Limit 2 A/D Channel
K19A	CH3	A/D Channel 3	+12VDC Starus A/D Channel
K19C	CH4	A/D Channel 4	Digital Pot. Level 1 A/D Channel
K20A	CH5	A/D Channel 5	Digital Pot. Level 2 A/D Channel
K20C	CH6	A/D Channel 6	Not used
K21A	CH7	A/D Channel 7	Not used
K21C	D/A1	D/A Channel 1	PWM Control
K22A	HLT2-	NMI2-	Console 2 Halt -
K22C	HLT2+	NMI2+	Console 2 Halt +
K23A	HLT1+	NMI1+	Console 1 Halt -
K23C	HLT1-	NMI1-	Console 1 Halt +
K24A	RXD2-	Receive Channel B- on U14	Console 2 Receive-
K24C	RXD2+	Receive Channel B+ on U14	Console 2 Receive+
K25A	RXD1-	Receive Channel A- on U14	Console 1 Receive-
K25C	RXD1+	Receive Channel A+ on U14	Console 1 Receive+
K26A	TXD2-	Transmit Channel B- on U14	Console 2 Transmit-
K26C	TXD2+	Transmit Channel B+ on U14	Console 2 Transmit+
K27A	TXD1-	Transmit Channel A- on U14	Console 1 Transmit-
K27C	TXD1+	Transmit Channel A+ on U14	Console 1 Transmit+
K28A	+12VDC	+12VDC Power	+12VDC Power
K28C	+12VDC	+12VDC Power	+12VDC Power
K29A	GND	Logic GND	Logic GND
K29C	GND	Logic GND	Logic GND
K30A	+5VDC	+5VDC Power	+5VDC Power
K30C	+5VDC	+5VDC Power	+5VDC Power
K31A	CS2	MC68332 Chip Select 2	Not used
K31C	CS3	MC68332 Chip Select 3	Not used
K32A	CS1	MC68332 Chip Select 1	Not used
K32C	CS4	MC68332 Chip Select 4	Not used

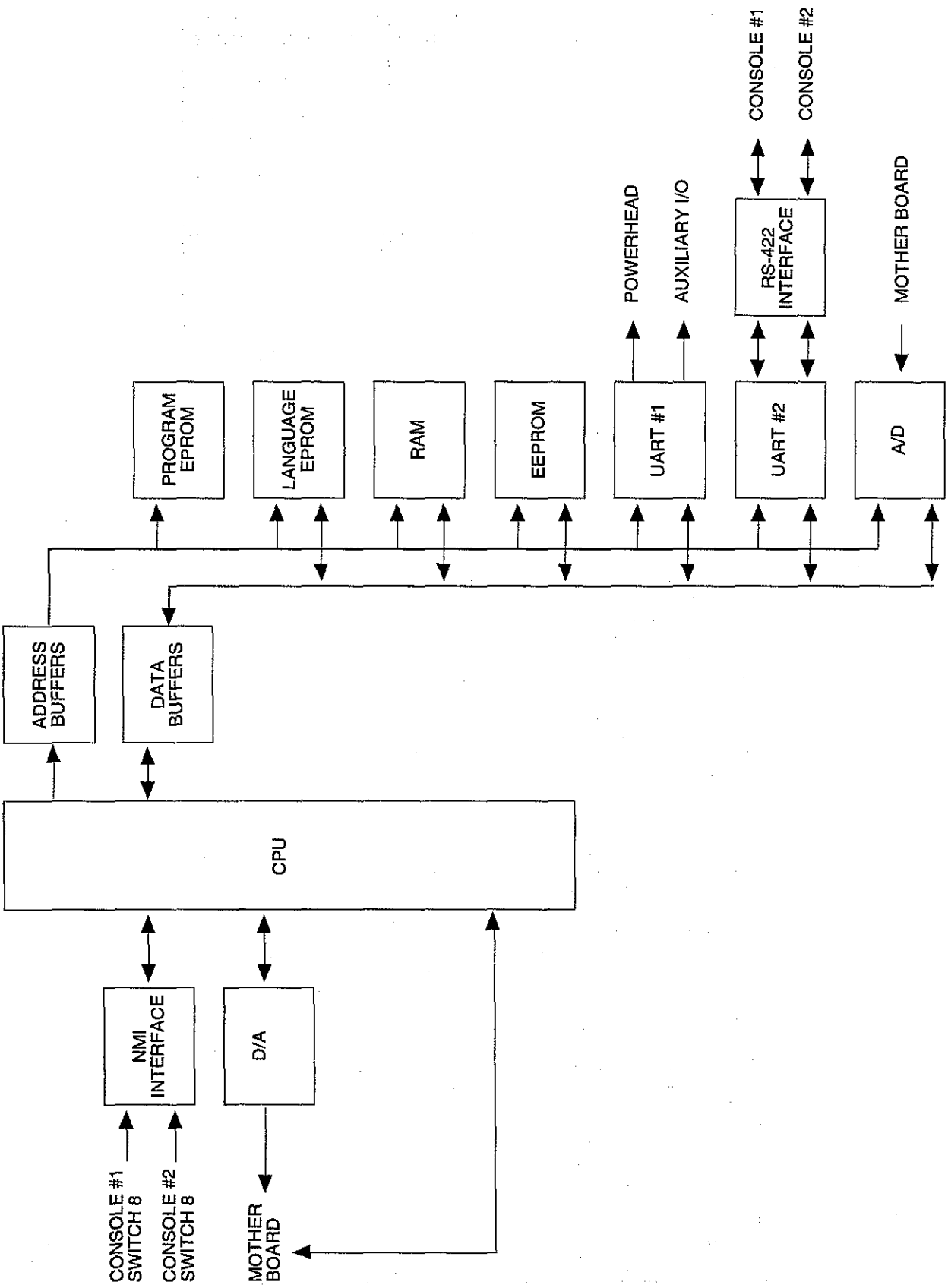

Figure 3-6. CPU Block Diagram

CONSOLE OVERVIEW

The console consists of four major functional sections. First is the MAIN CONSOLE board, second is the VIEWING ANGLE board, third is the KEYBOARD and fourth is the DISPLAY. Figure 3-7 shows a block diagram of these sections.

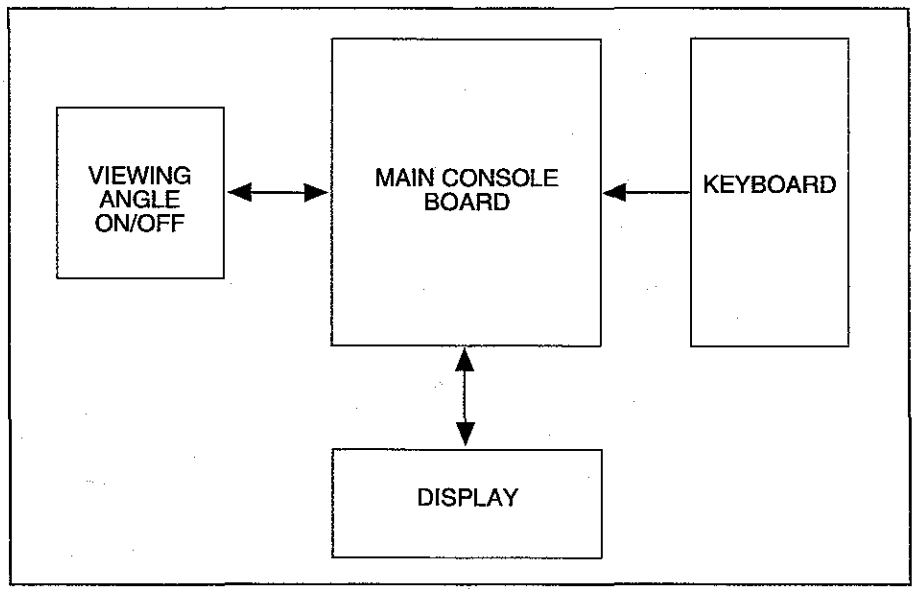

Figure 3-7. Console Overview

MAIN CONSOLE BOARD

The main console board consists of the following major components, each of which will be discussed in greater detail in the following sections:

- Power Supplies
- Keyboard Interface
- Speaker Control
- CPU
- Display Controller

Power Supplies

There are four power supplies on the main console board: +5V, +12V, -15V and 1000VAC.

With the exception of a small filter inductor, L3, added to the input of the regulators, the +5V and +12V supplies are identical to the +5V and +12V supplies on the MOTHERBOARD. Refer to the MOTHERBOARD theory of operation for a complete discussion of these circuits. +12V is used to power the speaker and the inverter used to generate the voltage for the cold cathode fluorescent tubes used to backlight the liguid crystal display. This inverter is not used on the EL versions of console (PCB P/N 800877). The +5V is used to power all remaining circuitry on the main console board.

Inverter INV-1 is used to convert +12V to the 1000VAC needed for the cold cathode fluorescent tubes used to backlight the display. The inverter is turned on and off by the CPU. A high signal placed on U26 pin11 is inverted twice by U26 and turns on FET Q1. This provides a ground path for the primary side of the inverter. A low signal on U26 pin11 turns the inverter off by opening the primary side ground path.

Switching regulator U23 is configured as a buck regulator to generate an adjustable negative voltage supply. This supply is used to control the viewing angle of the LCD. The voltage can range from -12V to -18V. Transistor Q4 is used to limit the top range of the viewing angle voltage input. Transistor Q2 chops the input D.C. voltage into a square wave. This square wave is then converted into a negative D.C. voltage by L4, D12 and C22. Capacitor C10 is used to set the switching frequency to 40 kHz.

Keyboard Interface

The eight keyboard switches are input to a buffer, U28, through series resistors, R40-R47. In addition each switch line is pulled up to +5V by R32-R39, and is prevented from exceeding +5V by diodes D3-D10. The output of the buffer is input to eight TPU channels of U22 (MC68332).

Speaker Control

One side of the console speaker is connected to +12V the other side is connected to the collector of transistor Q3. The base of Q3 is driven by one side of an RS-422 driver, U10. The frequency and duration of the base drive is controlled by U22 (MC68332) using one of the TPU channels. A capacitor, C33, is placed across the speaker to prevent damage from high voltage spikes.

Console CPU

The Console CPU consists of the following major components, each of which will be discussed in greater detail in the following sections:

- Microcontroller
- Battery Backed RAM
- RAM
- ROM

Power Up

When power is applied to the microprocessor, U22, a reset controller, U27 generates a low pulse on the microprocessor RESET line. The reset pulse must be at least 35µs to ensure a proper reset.

A diode, D11, is tied between data line D0 and the RESET pin so that D0 is pulled low when RESET goes low. This configures the port size of the CSBOOT chip select to 8 bits. This is necessary because CSBOOT is connected to an EPROM, U16 that has an 8-bit wide data bus.

Microprocessor Configuration and Operation

The microprocessor uses a 32.768 kHz crystal, X4, as a reference frequency source for an on-chip phase-locked loop which generates the 16.76 MHz clock speed.

The 16 external data lines (D0-D15) are buffered by two 8-bit 3-state non-inverting bus transceivers (U18, U19). The buffered data lines are used only by the LCD controller, U11. The LCD controller determines the bus transceiver direction.

Sixteen address lines (A0-A15) are also buffered by 8-bit 3-state non-inverting bus transceivers (U20, U21) and are input to the LCD controller.

Battery Backed RAM

The DS1386, U13, is a self-contained real time clock with 8K by 8-bits of battery backed RAM. It contains an embedded lithium energy source and a quartz crystal which eliminates the need for any external circuitry. Data contained within the 8K by 8-bit

memory can be read or written in the same manner as static RAM. U13 is used as the upper 8 bits of a 16-bit wide RAM address range.

RAM Operation

The Static RAM, U12, is socketed so that it can handle any JEDEC standard 32K x 8-bit RAM. Timing constraints require that the RAM speed be 100ns or faster. Note that the chip select line is tied to the output enable line, which means that the outputs will be enabled for both reads and writes. However, during a write operation, the output enable is a "don't care" input. U12 is used as the lower 8-bits of a 16-bit wide RAM address range.

EPROM Operation

Any JEDEC standard 32K x 8-bit EPROM may be used for the two EPROM, U14 and U16. Timing constraints require that the EPROM speed be 55ns or faster. The CPU system will boot from EPROM U16 as this contains the main console program. EPROM U14 contains the fonts and must also be present.

Table 3-10. Hardware Summary

U#	Description	Data Lines	Address Lines	Chip Select	IRQ
11	EPROM	PD0-PD15	A1-A18	6-10	7
12	EPROM-Lang.	PD0-PD7	A1-A15	1	
13	UART	PD0-PD15	A1-A15	2	1,2
14	EPROM	PD0-PD15	A0-A14	4	
15	EPROM	PD0-PD15	A0-A14	3	
16	EPROM	PD0-PD15	A0-A14	BOOT	

Display Controller

The display controller consists of an 82C455 flat panel VGA controller, U11, eight 64K x 4 DRAMS, U1-U8, and three oscillators, X1-X3.

The CPU transmits information to the display controller, U11. Flip-flop U25 is used to delay the display controller READY line for two MC68332 clock cycles so that the display controller can be read correctly by the MC68332. The display controller is responsible for generating the 4-bit wide video data stream used to refresh the display. In addition, the display controller generates all the sync and timing signals for the display and also generates the multiplexed row and column addresses used for both display refresh and CPU access of display memory.

The display controller supports a total of 256 Kbytes of display memory. The display controller serves as a DRAM controller for the systems display memory, U1-U8. It handles DRAM refresh, fetches data from display memory as required to refresh the screen, interfaces the CPU to display memory, and supplies all necessary DRAM control signals. The display memory is arranged as four planes of 64 Kbytes each. Each plane is made up of two 64K x 4 DRAMS as follows:

Plane 0 U6, U8

Plane 1 U5, U7

Plane 2 U1, U3

Plane 3 U2, U4

Oscillators X1 and X3 are used for internal display controller functions. Oscillator X2 is used to generate the dot clock which updates the LCD pixels.

VIEWING ANGLE BOARD

The VIEWING ANGLE board connects a potentiometer to the negative voltage supply on the main console board. This potentiometer adjusts the negative voltage which controls the LCD viewing angle. In addition, the remote on/off switch is connected to the board and is passed straight through to the main console board.

KEYBOARD

The keyboard consists of an 8 x 1 matrix. A conductive rubber keyboard is attached to the keyboard. Each key contains 6 conductive pads any one of which will short the key when pressed.

The console power LED is also connected to the keyboard.

DISPLAY

The display is a 640 x 480 triple super twisted nematic Liquid Crystal Display (LCD). Two cold cathode fluorescent tubes are used for backlighting.

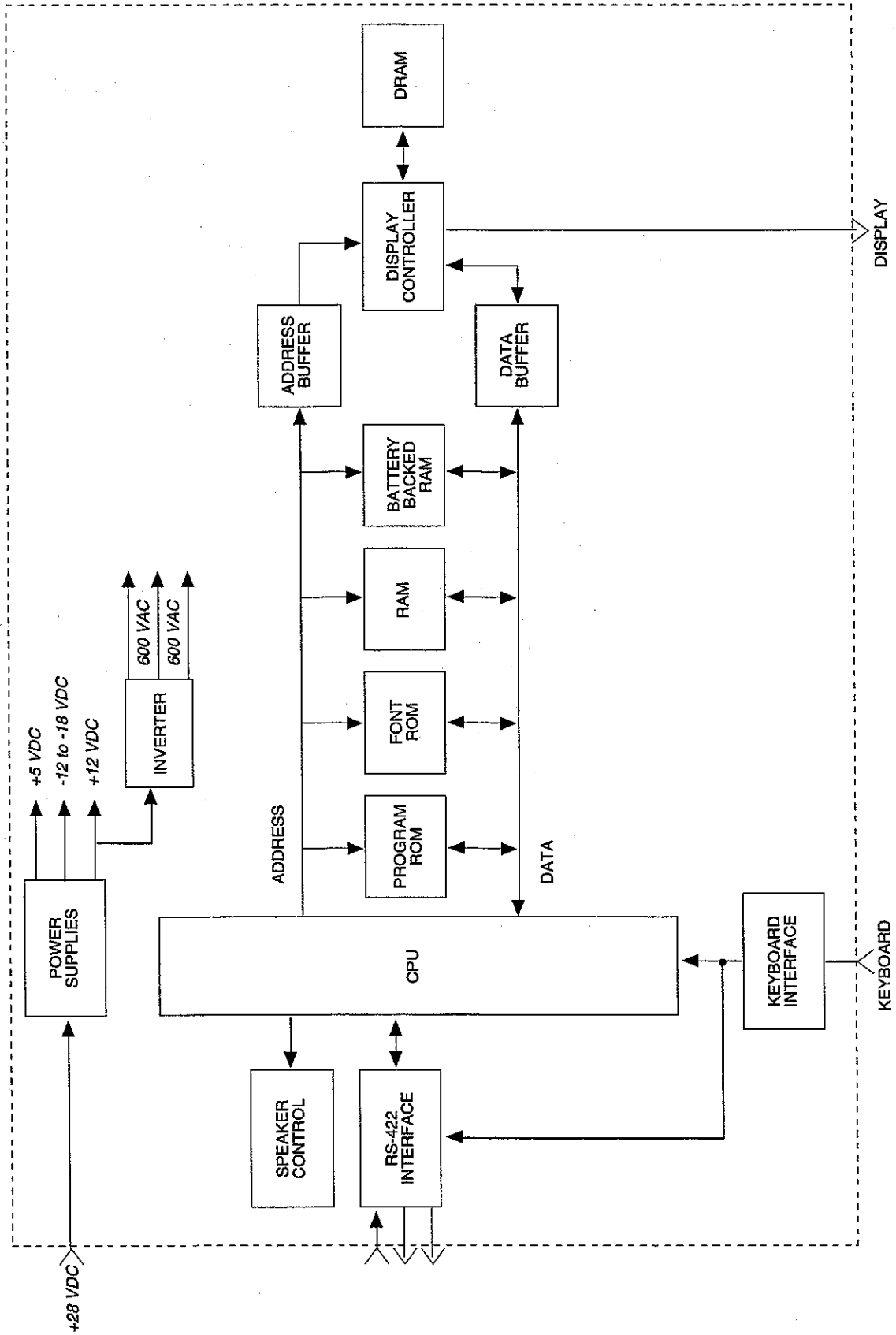

Figure 3-8. Console Block Diagram

POWERHEAD OVERVIEW

The powerhead holds the syringe and plunger, and contains an electric motor, gear train, and ballscrew to drive the plunger forward and reverse. An encoder mounted to the motor shaft and a linear potentiometer mounted to the ballscrew provide feedback to the Power Pack about the actual velocity and position of the plunger.

The major functions of the powerhead are shown in Figure 3-9. These major functions are described below:

- To drive the syringe plunger the head transforms electrical power into rotary motion with a motor, then into linear motion with a ballscrew assembly.
- To keep track of the plunger's velocity and position, the head contains two feedback devices: a linear potentiometer mounted to the ballscrew and an optical encoder mounted to the motor shaft.
- A heater blanket maintains the temperature of the fluid in the syringe through a temperature controlling circuit.
- Push-buttons allow the operator to move the plunger forward or reverse for loading or expelling. A knob encoder provides feedback to the powerhead CPU which informs the Power Pack that a slow plunger movement is requested.
- The head contains sensors which detect syringe size and face plate position.
- Lamps are provided which indicate when the injector is enabled, when it is injecting and when a fault has occurred.
- A three digit LED display indicates the remaining volume in the syringe or the Auto-Fill volume requested.
- A three digit LED display indicates the syringe size of the face plate.

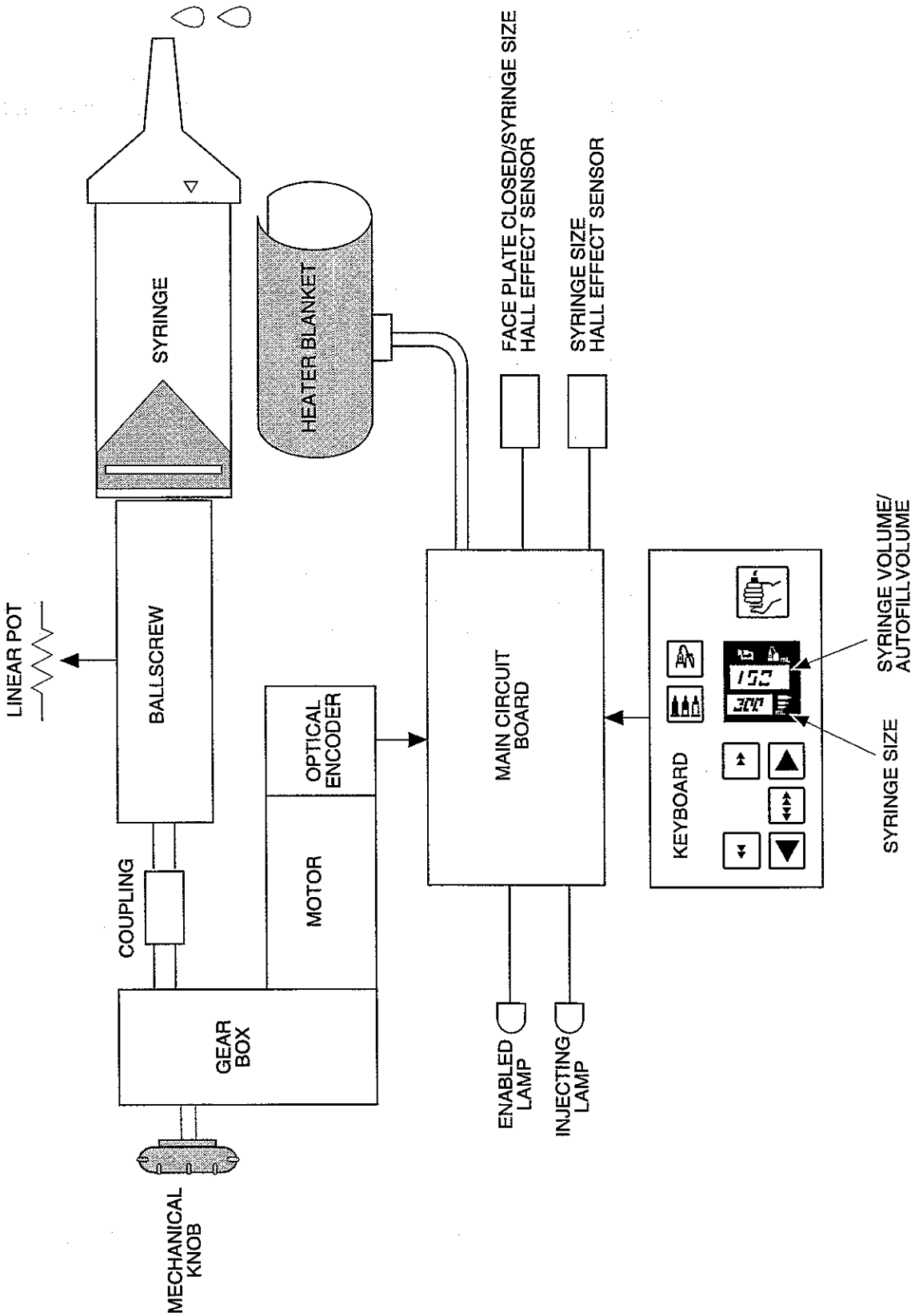

Figure 3-9. Powerhead Functional Diagram

MAIN POWERHEAD BOARD

The main powerhead board consists of the following major components, each of which will be discussed in greater detail in the following sections:

- Microcontroller
- Heater blanket controller
- RS-422 interface
- Keyboard and sensor interface
- Power Supplies
- Knob Encoder interface
- Lamp interface
- Motor interface
- Status LEDs

The Power Pack provides a female DB-25 connector which connects to the male end of the powerhead cable. Table 3-11 contains the connector pinout and signal description for the DB-25 connector. The female end of the cable connects to a male DB-25 connector located on the powerhead circuit board.

Table 3-11. Powerhead DB-25 Pin Designations

J5 Pin	Signal Name	Signal Description
1	CHGND	Chassis GND
2	MOTPWR-	Motor power
3	MOTPWR-	Motor power
4	MOTPWR-	Motor power
5	MOTPWR+	Motor power
6	MOTPWR+	Motor power
7	MOTPWR+	Motor power
8	GND	Signal GND
9	GND	Signal GND
10	GND	Signal GND
11	CHGND	Chassis GND
12	CHGND	Chassis GND
13	TXD+	Head data receive+
14	+12V	Logic power
15	+12V	Logic power
16	+12V	Logic power
17	ENCTRL	ENABLED lamp control
18	INJCTRL	INJECTING lamp control
19	RCV+	Head data receive +
20	RCV-	Head data receive -
21	ENCB-	Motor encoder phase B -
22	ENCA-	Motor encoder phase A -
23	ENCA+	Motor encoder phase A +
24	ENCB+	Motor encoder phase B +
25	TXD-	Head data transmit

MICROCONTROLLER

The microcontroller, U1, is an MC68HC11E2. The powerhead software is stored inside the microcontrollers EEPROM. The microprocessor uses a 4.9152 MHz crystal, X1, to generate the system clock. This value was chosen to provide accurate baud rate times. A power up reset and low voltage detect circuit is implemented using U6, RN2-8 and C4.

HEATER BLANKET CONTROL

The heater blanket is powered by the +12VDC supplied by the Power Pack. In order for the +12VDC to be applied to the heater blanket element, the microprocessor must turn on relay K2 and transistor Q1.

Two thermistors located in the heater blanket provide temperature feedback to the microcontroller. When the injector first turns on, the microcontroller outputs a high duty cycle PWM signal to Q1. As the desired heater blanket temperature is reached the microcontroller will decrease the PWM duty cycle. When the heater blanket temperature falls below the desired temperature the microcontroller will increase the PWM duty cycle. LED DS-4 will turn on and off with the PWM signal.

RS-422 INTERFACE

The two motor encoder channels and the microcontroller communications transmit line are input to an RS-422 transmitter, U3 pins 1, 7 and 9. These signals are then transmitted to the Power Pack. In addition, the RS-422 communications data transmitted from the Power Pack to the powerhead are converted by the RS-422 receiver U5 pin 3.

KEYBOARD AND SENSOR INTERFACE

The keyboard contains eight normally open switches: fill, expel, start/pause, three fast switches, Auto-Fill Mode and Auto-Fill Volume. The three "fast" switches are electrically tied together. One side of each switch is connected to an input port on the microcontroller. Each of these lines is pulled up by a resistor, RN-1 or RN-2. The other side of the switches are tied to ground. Therefore, a high voltage on the input port indicates the switch is open. A low voltage on the input port indicates the switch is closed.

Refer to schematic LF P/N 800573 at the end of this chapter. There are two bipolar hall effect sensors mounted to the hall effect circuit board and connected to the powerhead PCB via ribbon cable J13. The sensors detect the polarity of the magnets in the face plate and locking ring. The two signals, called "Face Plate A" and "Syringe Present A", are driven low when a magnetic south is detected. The two signals, called "Face Plate B" and "Syringe Present B", are driven low when a magnetic north is detected. All four of these signals remain high when no magnet is present. Table 3-12 below indicates the size and type of the syringe sensed by the powerhead for all possible face plate magnate conditions.

NOTE: *There must be a magnet present (i.e., either north or south polarity) at the Syringe Present sensor in order for the system to function.*

Table 3-12. Syringe Size Sensing

	Syringe Present A	Syringe Present B
No Face Plate Magnet	200 mL (Liebel-Flarsheim)	100 mL Hand-Held
Face Plate A	125 mL Prefilled	30/50 mL Prefilled
Face Plate B	Reserved	200 mL Hand-Held

DISPLAY

Refer to schematics LF P/N 800569 and LF P/N 800563 at the end of this chapter. The Display PCB is connected to the Powerhead PCB via the ribbon cable J8. Cable J8 also provides the connection to the keyboard. The microcontroller communicates to the display controller through a four wire serial bus. The Display is divided into two sections: the three digit "Syringe Size" indictor, and the three digit "Remaining Volume / AutoFill Volume" indicator. The backlit symbol indicates the active function of this Powerhead (i.e., Remaining Volume or AutoFill Volume).

POWER SUPPLIES

The Power Pack supplies +12VDC to the powerhead. A voltage regulator, VR2, is used to generate +5VDC. The linear potentiometer, used for position sensing, does not travel fully to its opposite limit (i.e. 0V), a voltage divider circuit consisting of R1, R4 and R18, is used to generate reference voltages for the microcontrollers A/D. This divider circuit produces a usable range of approximately 4.9V (Vrh) to 0.21V (Vrl). This corresponds to the range of the linear potentiometer using the 5.0V supply. By using the linear potentiometer supply to generate the A/D reference voltages the two devices will track each other in case of voltage fluctuations.

LAMP INTERFACE

The enabled and injecting lamp are powered by the power pack. The powerhead board simply passes the control signals from the powerhead connector to the lamp connector J4.

MOTOR INTERFACE

The motor power is passed through a normally open relay, K1, before being connected to the motor via J5. When open, the relay shorts the two motor leads together providing dynamic braking of the motor. When closed, the relay simply passes the two motor lines supplied by the Power Pack to the motor. K1 is energized by the microcontroller whenever the motor should move. A snubber circuit, SN1, is connected across the motor leads for noise suppression.

STATUS LEDS

There are five status LEDs used on the powerhead. The meaning of each is shown below:

Table 3-13. Status LED's

LED#	Description	ON	OFF
1	+5 VDC	+5 VDC	0 V
3	Not used	-	-
4	Heater PWM	Heat	No Heat
5	Not Used	-	-
6	Motor Encoder Direction	Expel	Fill

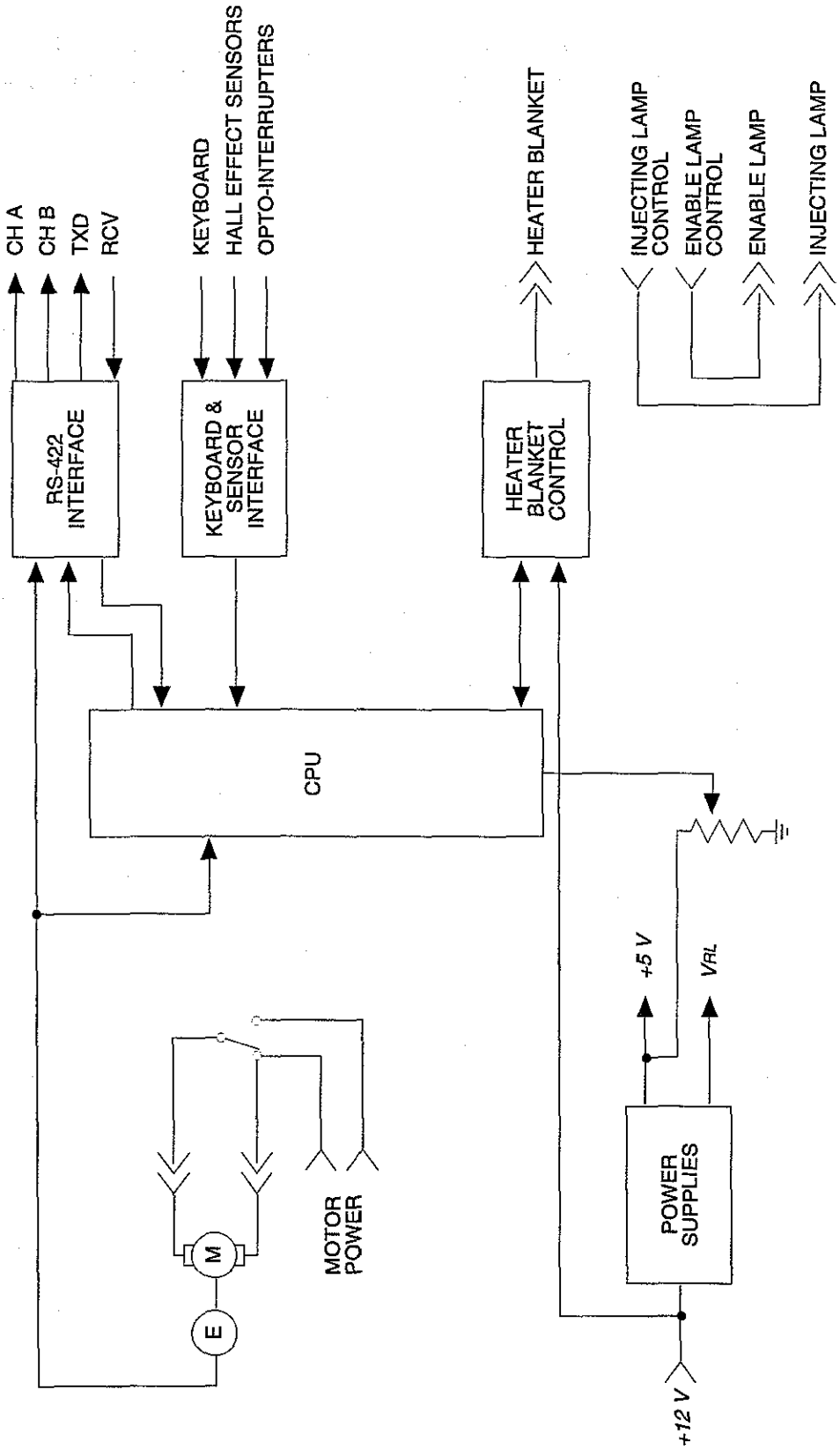

Figure 3-10. Powerhead Block Diagram

UNIVERSAL INTERFACE

Refer to schematic LF P/N 800941 at the end of this chapter. The Universal Interface may be installed in either of two separate configurations determined by the internal cable assembly (P/N 800261). The Interface may be either a two wire or four wire system.

The Universal Interface couples the injector to an imaging system. The imaging system can trigger the injector to start by closing a switch between pins J3-13 and J3-14 of the universal interface connector as shown in Figure 3-12 and schematic 800941 (and as depicted in Figure 3-11 as pins 1 and 2 of the 4-pin universal interface connector). When the ground from J3-13 is applied to J3-14, the signal called Remote Start 1 is driven low and turns on optocoupler U9. This low signal is inverted at U5 and is sensed as a high signal on U4 pin 42. The main processor detects this signal, and initiates an injection. However, if a scan delay has been programmed into the console processor from the selected protocol, the main processor sends an output at U4 pin 31 (i.e., OP2) to pin 1 of inverter U2 when the scan delay has expired. The injector energizes relay K1 (CT Scan Control Signal) which provides contact closure, allowing the imaging system to start the image.

For the two wire system refer to general wiring diagram Fig 3-13 and detailed wiring diagram Fig 3-14. In this configuration the Injector is started manually by the CT technologist. If a Scan Delay has been programmed on the Injector for this injection, the Injector closes Relay K4 at the end of the Scan Delay. This closure can be used by the imaging system to start the imaging scan. If there is no Scan Delay programmed, the Injector closes Relay K4 at the beginning of the injection.

In either configuration: if the Scan Delay is shorter than the injection duration Relay K4 will open at the end of the injection, otherwise the relay will be closed for a minimum of .5 seconds.

CAUTION!

The external start connection must not apply voltage to the start circuit. Only a switch closure may be provided. If the external start connection applies voltage to the start circuit, the start circuit could be damaged.

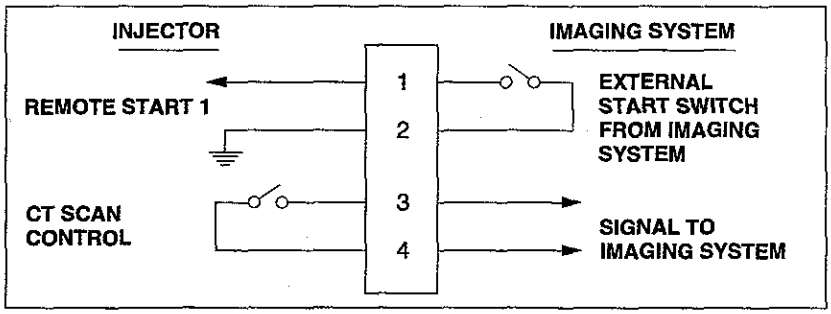

Figure 3-11. Universal Interface Connections

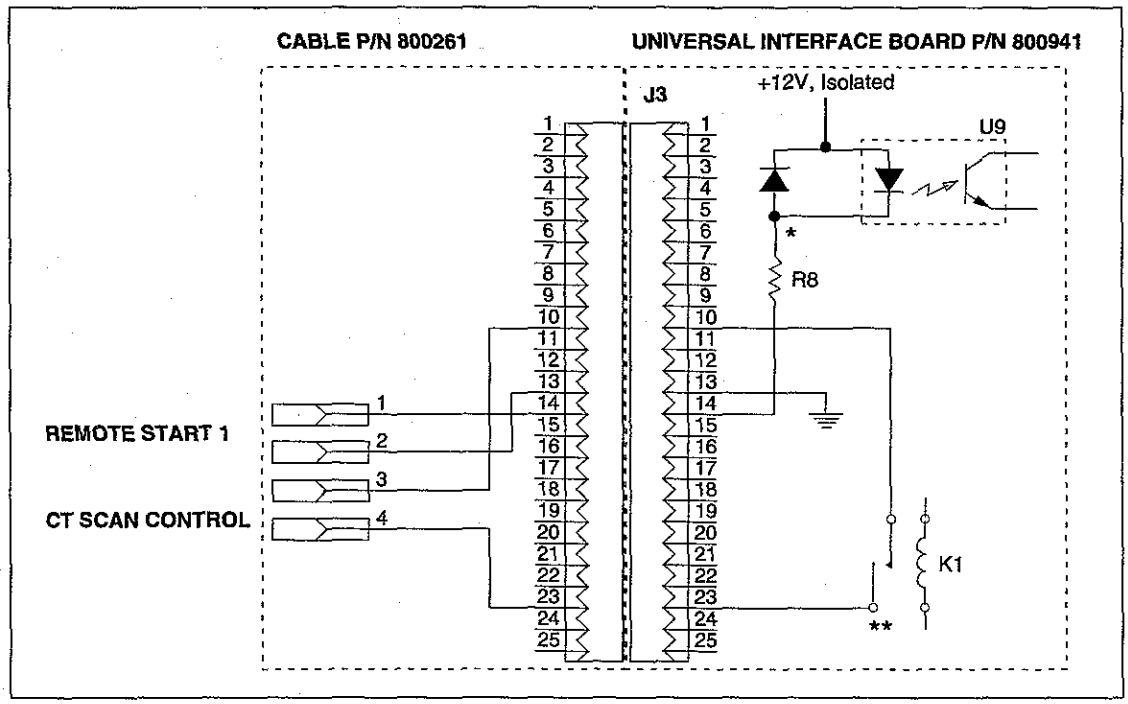

Figure 3-12. Universal Interface Connections (Detail)

NOTE: *Imaging System Remote Start Relay Contact or Switch Load: 10 mA @ 12 VDC resistive.*

NOTE: *Injector Scan Control Relay Contact Ratings: Resistive: 125 VAC 0.3A: 30 VDC 1A. Inductive: 125 VAC 0.2A: 30 VDC 0.5A*

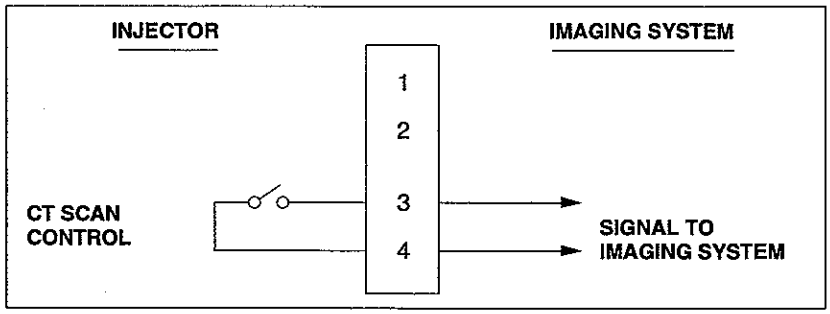

Figure 3-13. Universal Interface Connections

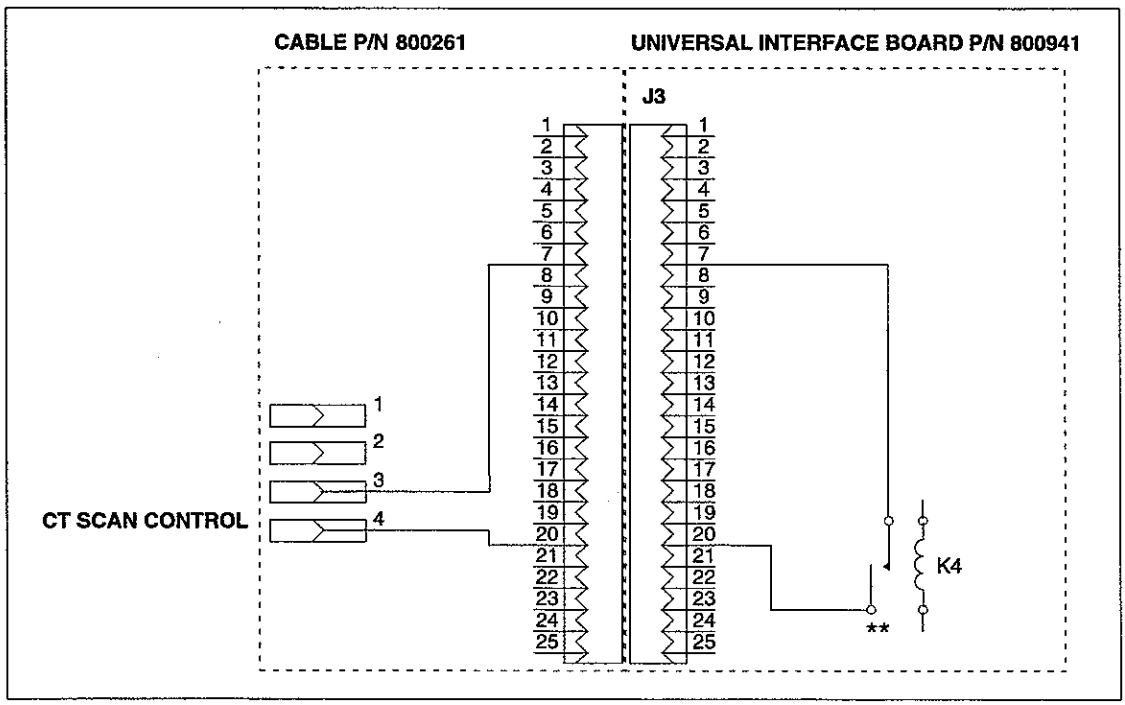

Figure 3-14. Universal Interface Connections (Detail)

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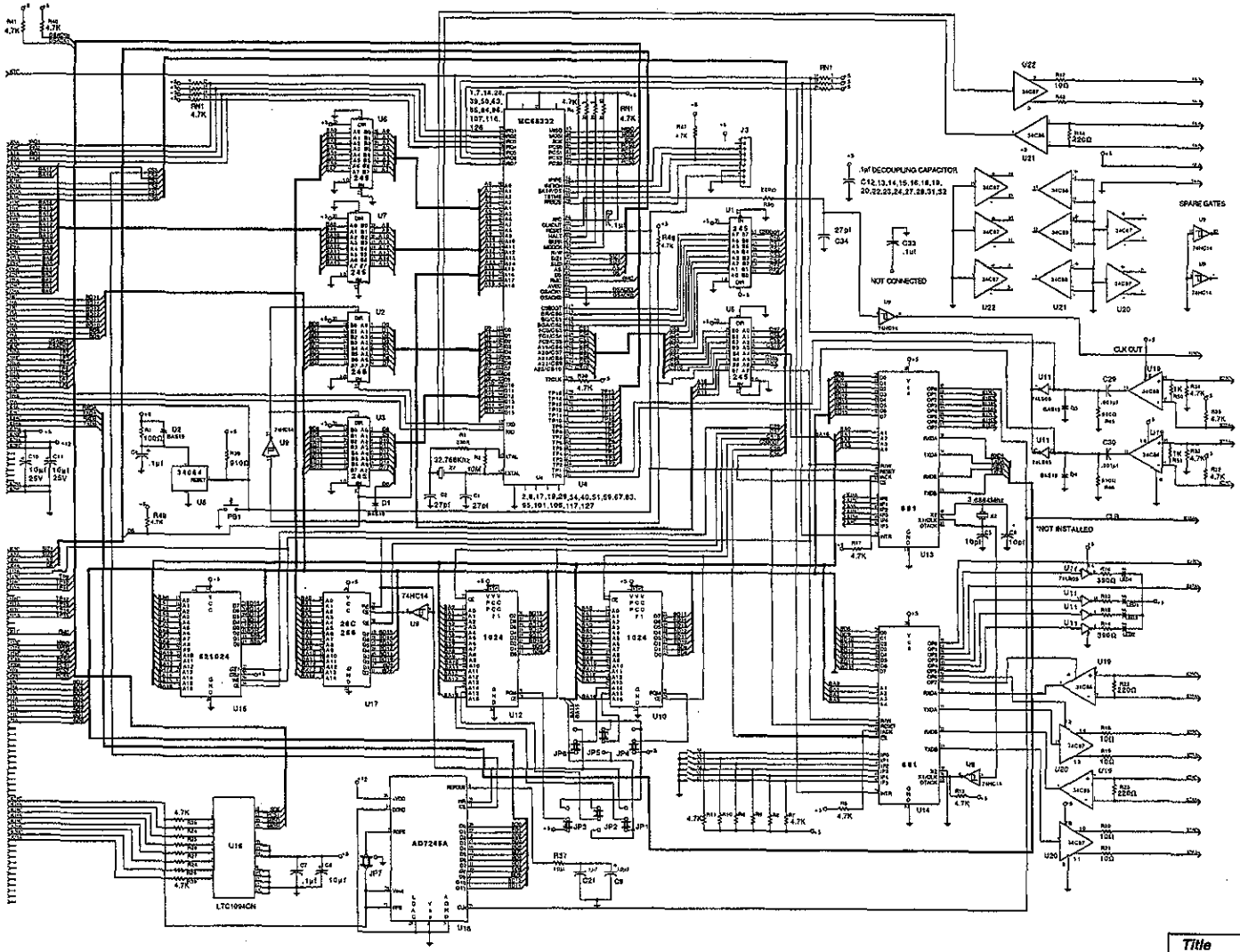
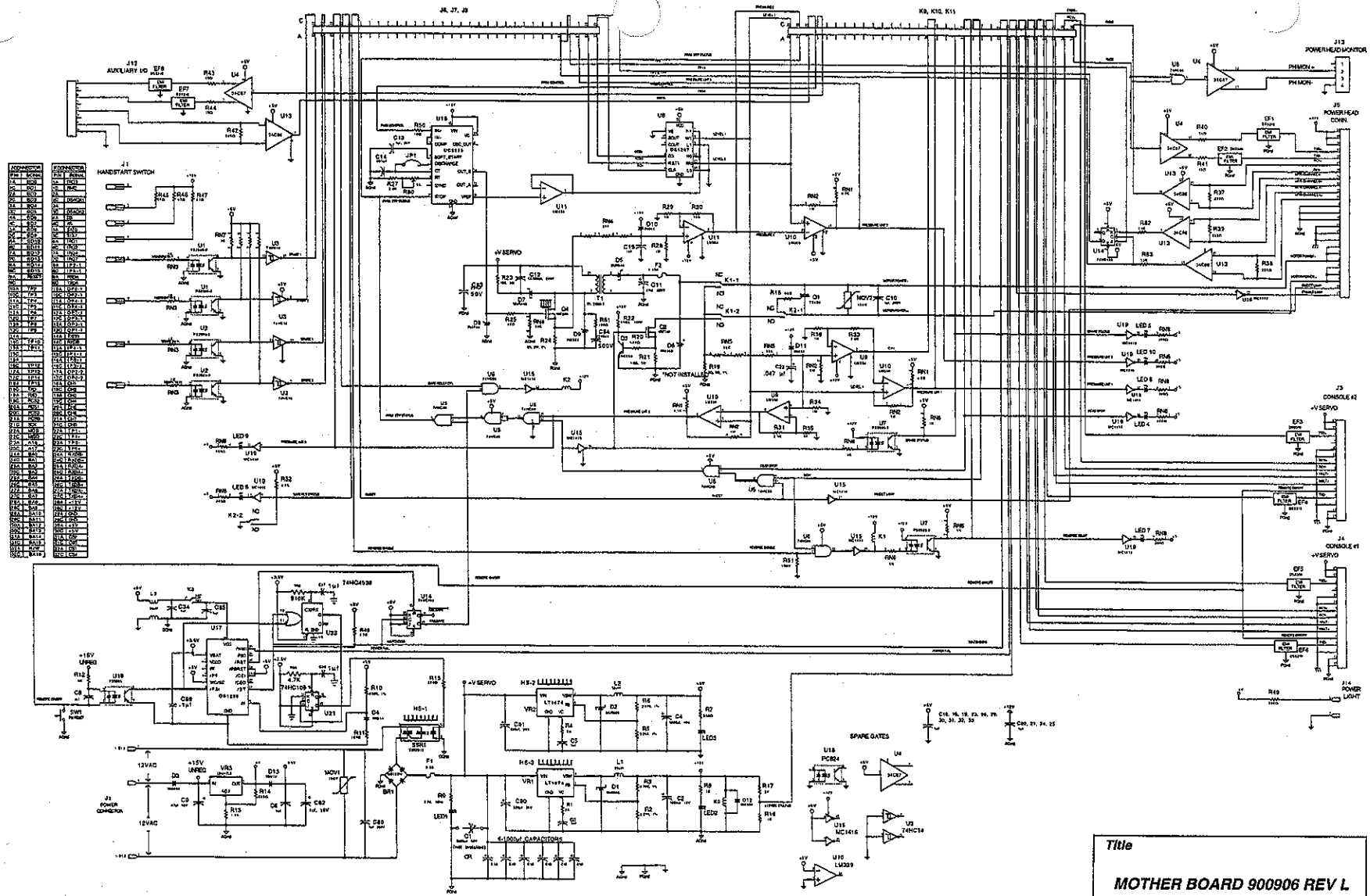
SCHEMATICS



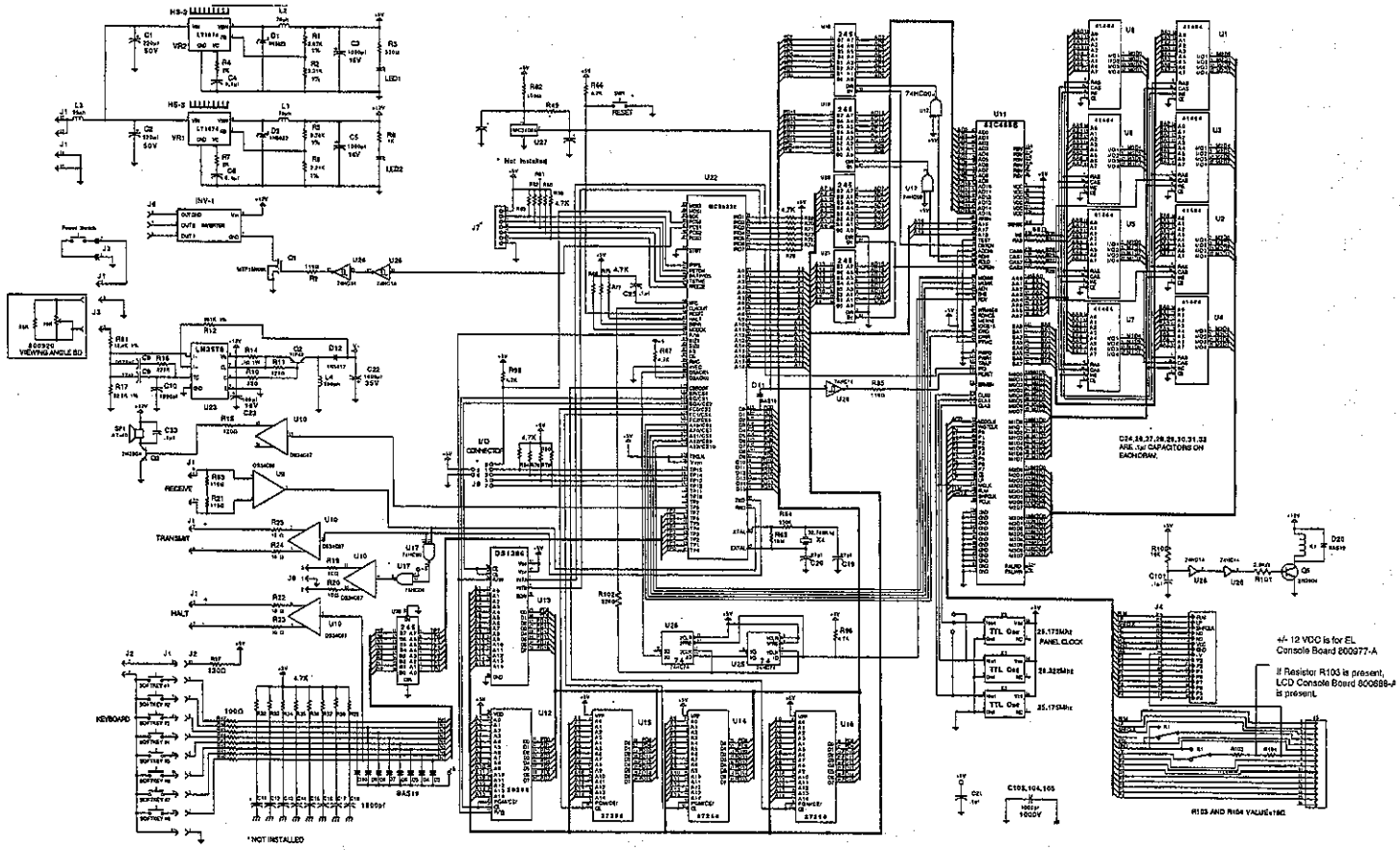
Title

CPU BOARD 800902 REV G



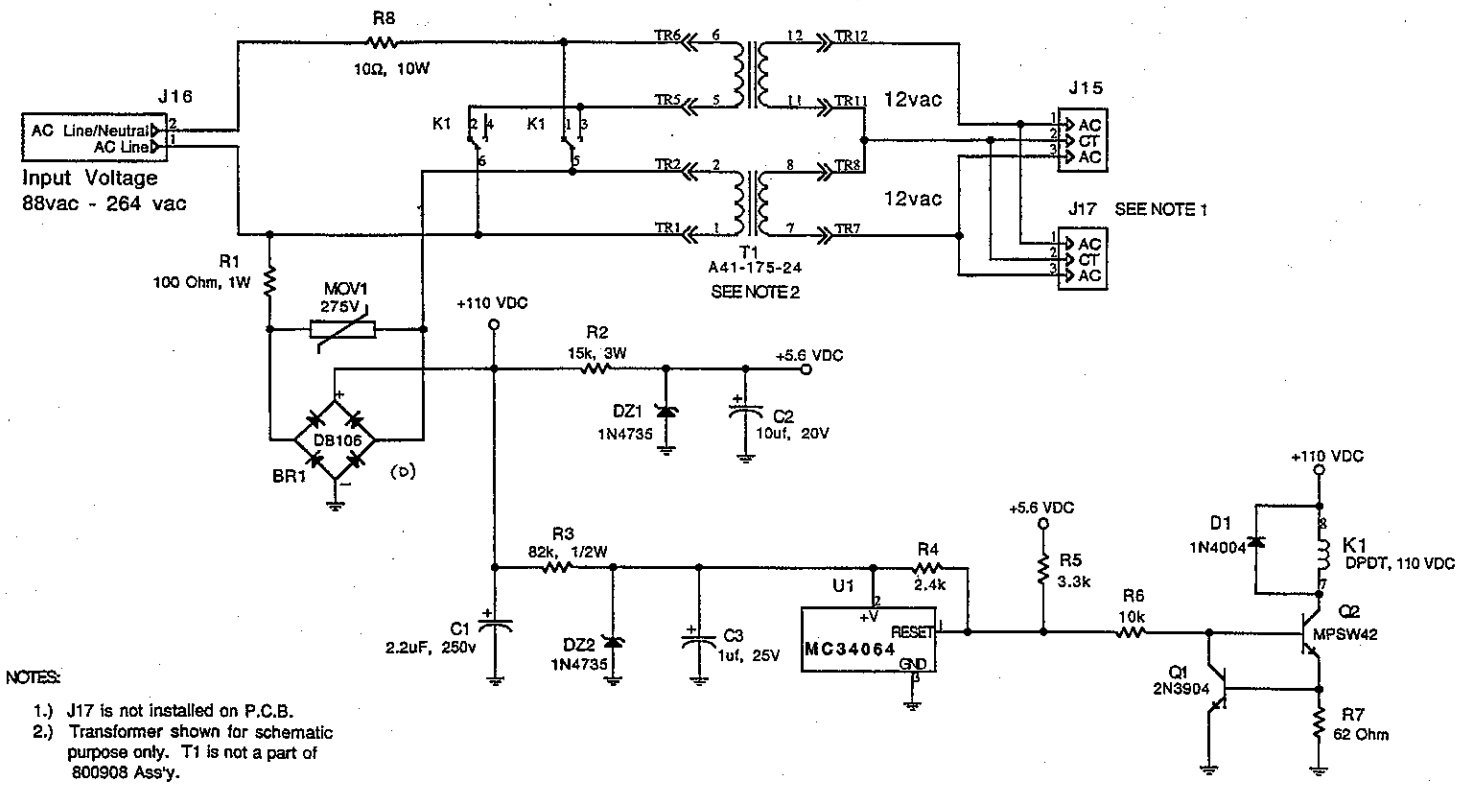
Title

MOTHER BOARD 900906 REV L



Title

CONSOLE BOARD
800888-A FOR LCD DISPLAY
800977-A FOR EL DISPLAY

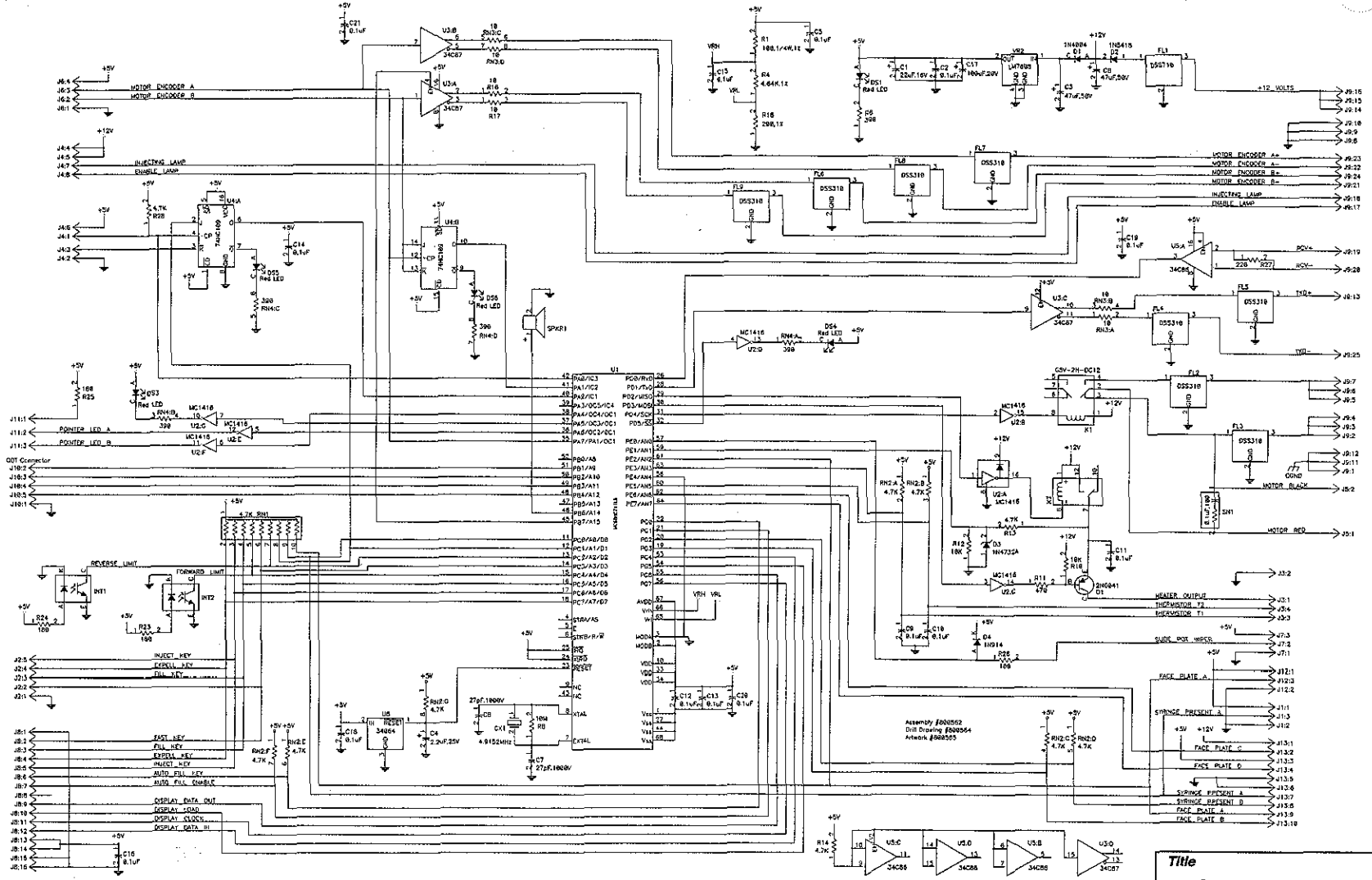


NOTES:

1.) J17 is not installed on P.C.B.
2.) Transformer shown for schematic purpose only. T1 is not a part of 800908 Ass'y.

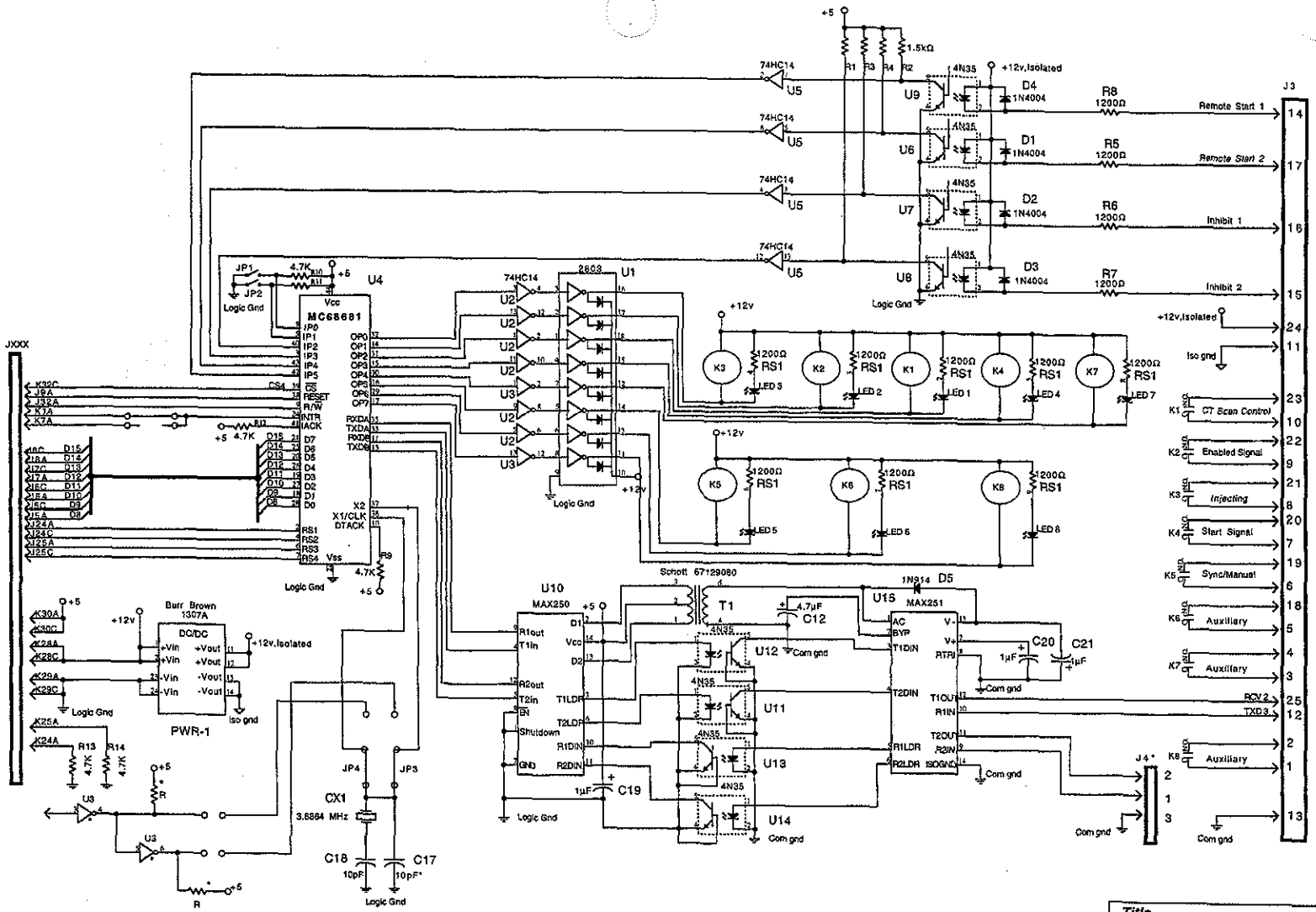
Title

VOLTAGE SELECT BOARD 800908 REV E



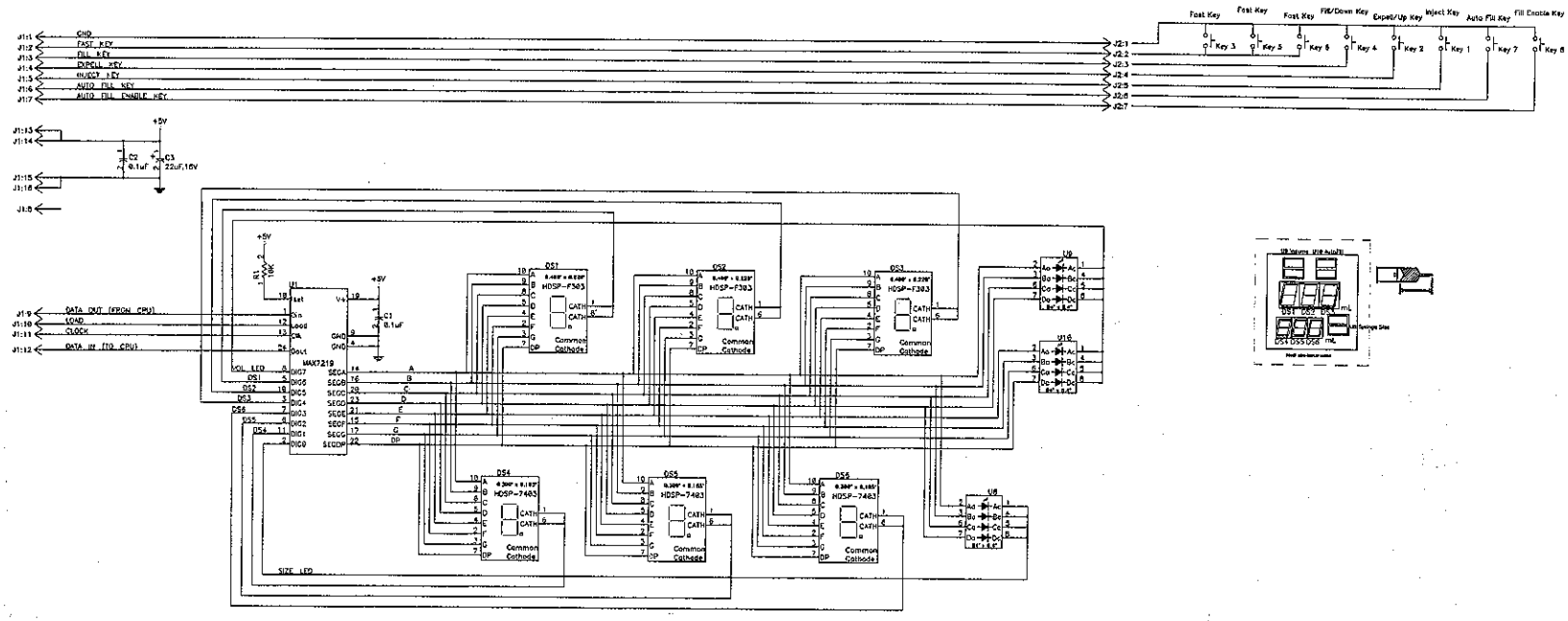
Title

CT 9000 POWERHEAD BOARD 800563 REV A



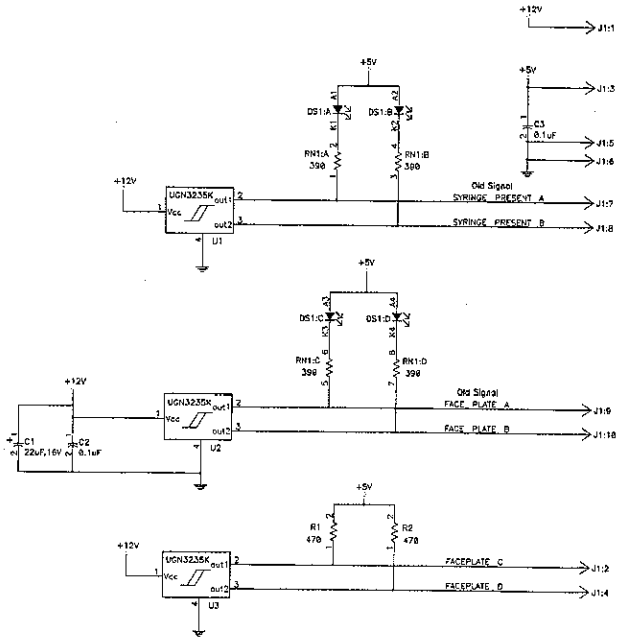
Title

UNIVERSAL INTERFACE BOARD 800941 REV F



Title

CT 9000 DISPLAY SCHEMATIC 800569 REV A



Title

CT 9000 HALL EFFECT BOARD 800573 REV A

4 TROUBLESHOOTING

This chapter includes descriptions of the Error and Fault Messages of the CT 9000. Refer to the Parts Section of this Manual for exploded drawings of the Power Pack (i.e. Electronics Cabinet), Powerhead, and Console in order to obtain a thorough understanding of disassembling these components. Critical dimensions for reassembly of the Powerhead are included at the end of this chapter.

DANGER! SHOCK HAZARD!
Be extremely careful when the CT 9000 is open. Lethal voltages are exposed. Be careful not to leave an open system unattended with power plugged. in. DISCONNECT THE POWER CORD BEFORE DISASSEMBLING THE SYSTEM, AND BEFORE REMOVING OR REPLACING BOARDS.

ERROR AND FAULT MESSAGES

The CT 9000 generates messages in response to operator input and the monitoring of equipment status. These messages fall into two general categories:

Error Messages—Those messages that appear in response to incorrect operator input.

Error Codes—Those codes that appear in response to incorrect operator input.

Fault Messages—Those messages that appear when the CT 9000's self-diagnostics detect a problem in the control circuitry.

With a few noted exceptions, the Error Messages can be corrected by the operator.

ERROR MESSAGES

INJECTION WAS PRESSURE LIMITED

Occurs when: The required pressure to deliver protocol exceeds the Pressure Limit value or when an obstruction is present in the line or catheter.

Operator Action: Reduce the flow rate or increase the Pressure Limit. Check for obstruction in line or catheter.

Insufficient Syringe Volume!
Press OVERRIDE to inject available volume.

Occurs when: The protocol volume is greater than the volume available in the syringe.

Operator action: Reset protocol volume to a level lower than the syringe volume or press [OVERRIDE] to use existing volume.

Invalid Injection!
Press EXIT to continue.

Occurs when: The [Enable] key is pressed when in Protocol Memory or Change Values Screen while a protocol parameter is invalid or the available syringe volume is 0.

Operator action: Press [EXIT] to return to the Protocol Memory screen or the Change Values screen and enter a valid parameter.

Lock the syringe in place.

Occurs when: The operator attempts to enable a protocol when the syringe face plate is not in the locked position or when the face plate is opened while the injector is running.

Operator action: Ensure the syringe face plate is in the Locked position. Refer to Chapter 5 for more information.

That name already exists!

Occurs when: The operator tries to enter a blank name or the name of a protocol that already exists in memory.

Operator action: Choose a new name for the protocol.

Heater thermistor tracking error.
To continue, press override. See manual for further instructions.
(See also Fault Message # 22)

Occurs when: A problem with the heater blanket has been detected.

Operator action: Press [Override], power down the unit and disconnect the heater blanket. Discontinue use of the heater blanket until serviced by a qualified Liebel-Flarsheim service technician. The CT 9000 is completely functional, however, the temperature of heated contrast cannot be maintained.

Overheating error.
To continue, press override. See manual for further instructions.
(See also Fault Message # 23)

Occurs when: A problem with the heater blanket has been detected.

Operator action: Press [Override], power down the unit and disconnect the heater blanket. Discontinue use of the heater blanket until serviced by a qualified Liebel-Flarsheim service technician. The CT 9000 is completely functional, however, the temperature of heated contrast cannot be maintained.

ERROR CODES

E0

Occurs when: A pressure plate has not been installed and the operator presses the [AutoFill] key.

Operator action: Install the appropriate pressure plate prior to activating the AutoFill function.

E2

Occurs when: With a pressure plate installed, the operator presses the [AutoFill] key, however the ram has not been moved far enough for the AutoFill function to be activated.

Operator action: Continue to move the ram to until it is fully extended.

FAULT MESSAGES

The dual microprocessor control circuits in the CT 9000 continuously monitor all important functions from the moment that the unit is turned on. These checks, transparent to the operator, occur many times each second, monitoring the safe performance of the injector. If a fault is detected, the unit will lock into the Fault Mode and then display a Fault Message. Refer to Figures 4-1 and 4-2.

In all cases, the appearance of a Fault Message requires that the operator contact a qualified service technician to correct the problem. A listing of these Fault Messages, along with its corrective action, follows.

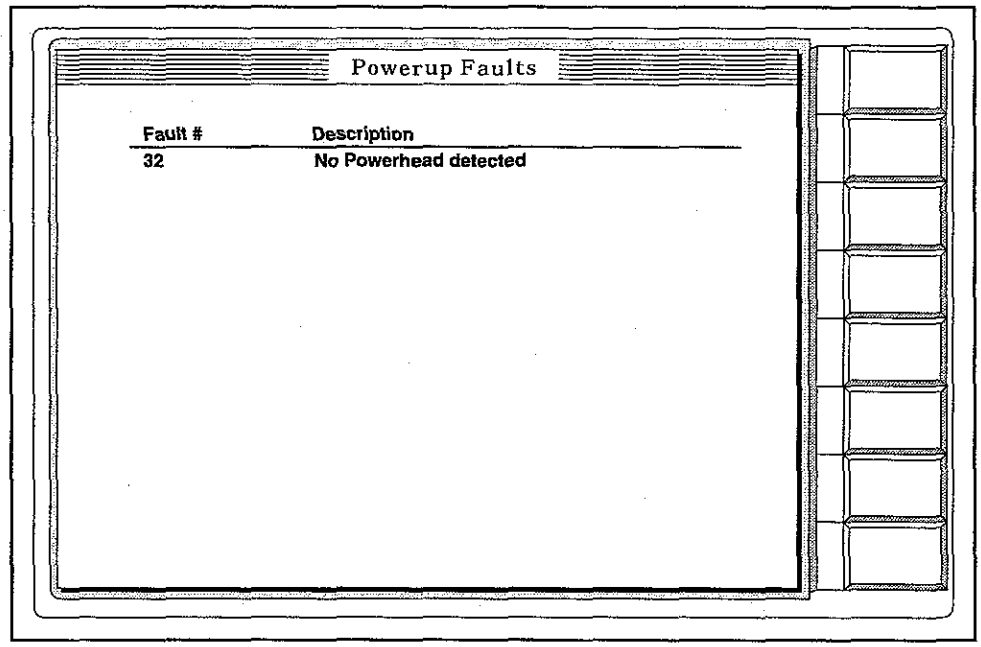


Figure 4-1. Fault Message Appearing at Powerup

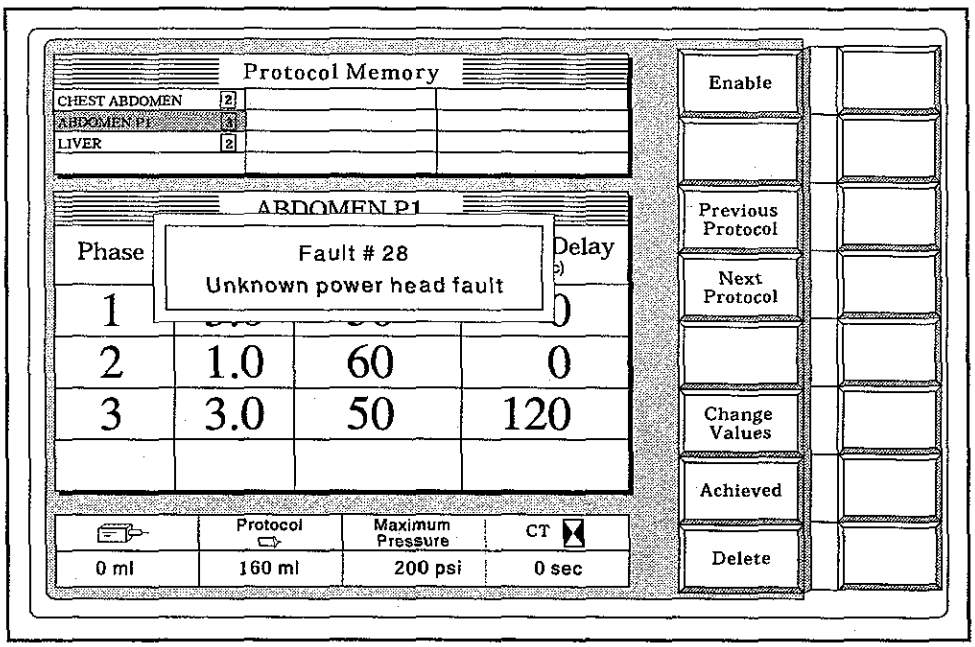


Figure 4-2. Fault Message Appearing Protocol Memory Menu

Fault # 001
Brake did not turn off

Occurs when: The Brake Status signal, located on the Mother board, is checked during Power-up testing. Pin 1 of U6 is toggled low by the CPU causing a low output by U6 pin 3. This signal is inverted by U15 to cause the Brake Status signal U7 pin 8 to toggle high. If a problem exists to cause the output to toggle low, the CPU will display the Fault message at the end of Power-up testing.

Corrective action: Check the Brake Status circuitry of U5, U6, U7 and U15 on the Mother board.

Fault # 002
Brake did not turn on

Occurs when: The Brake Status signal, located on the Mother board, is checked during Power-up testing. Pin 1 and pin 2 of U6 are toggled high by the CPU causing a high output by U6 pin 3. This signal is inverted by U15 to cause the Brake Status signal U7 pin 8 to toggle low. If a problem exists to cause the output to toggle high, the CPU will display the Fault message at the end of Power-up testing.

Corrective action: Check the Brake Status circuitry of U5, U6, U7 and U15 on the Mother board.

Fault # 003
Reverse relay would not turn off

Occurs when: The Reverse Relay control signals, located on the Mother board, is checked during Power-up testing. Pin 13 and pin 12 of U6 are toggled low by the CPU, causing the output of U6 pin 11 to go low. This low signal then causes the output of U7 pin 6 to go high. If a problem exists to cause the output to stay low, the CPU will display the Fault Message at the end of Power-up testing.

Corrective action: Check chips U6, U15 and U7 on the Mother board.

Fault # 004
Reverse relay would not turn on

Occurs when: The Reverse Relay control signals, located on the Mother board, are checked during Power-up testing. Pin 13 and pin 12 of U6 are toggled high by the CPU, causing the output of U6 pin 11 to go high. This high signal then causes the output of U7 pin 6 to go low. If a problem exists to cause the output to stay high, the CPU will display the Fault Message at the end of Power-up testing.

Corrective action: Check chips U6, U15 and U7 on the Motherboard.

Fault # 005
Safe relay would not turn off

Occurs when: During Power-up testing, relay K2 on the Mother board is monitored by the CPU to ensure that it turn off. U6 pin 9 is set low by the CPU and U6 pin 10 is kept low due to the CPU not toggling U14 pin 12. If a problem exists to cause the output to toggle incorrectly, the CPU will display the Fault message at the end of Power-up testing.

Corrective action: Check chips U14, U6, U15 and Relay K2 on the Mother board.

Fault # 006
Safe relay would not turn on

Occurs when: During Power-up testing, relay K2 on the Mother board is monitored by the CPU to ensure that it toggles accurately according to the inputs of U6 pin 9 and pin 10. If a problem exists to cause the output to toggle incorrectly, the CPU will display the Fault message at the end of Power-up testing.

Corrective action: Check chips U14, U6, U15 and Relay K2 on the Mother board.

Fault # 009
Safe relay turned on with no failsafe

Occurs when: During Power-up testing, the safe relay failsafe is tested to ensure that it is not stuck in an unsafe state. U6 pin 9 is set high by the CPU but the failsafe (U14 pin 12) is not toggled. If the safe relay turns off the CPU, the CPU will display the Fault message at the end of Power-up testing.

Corrective action: Check chips U14, U6, U15 and Relay K2 on the Mother board.

Fault # 010
PWM stop turned off with no failsafe

Occurs when: During Power-up testing, the PWM STP STATUS line (U5 pin 3) is checked to ensure that the PWM controller, U16, is not active unless the failsafe is toggled. U6 pin 1 is toggled low, causing U5 pin 2 to be low. The failsafe is not toggled, so U5 pin 1 should also be low If the output of U5 pin 3 is not high, the CPU will display the Fault message at the end of the Power-up testing.

Corrective action: Check chips U5, U6 and U14 on the Mother board.

Fault # 011
PWM D/A conflicts with A/D (5V)

Occurs when: During Power-up testing, the CPU outputs +5V on the D/A, U18 pin 3 located on the CPU board. The output value is read by the A/D, U16 pin 1 on the CPU board. Any discrepancy between the two values will cause the CPU to display the Fault message at the end of Power-up testing.

Corrective action: Check chips U16 and U18 on the CPU board and U8 on the Mother board.

Fault # 012
PWM D/A conflicts with A/D (2.5V)

Occurs when: During Power-up testing, the CPU outputs +2.5V on the D/A, U18 pin 3 located on the CPU board. The output value is read by the A/D, U16 pin 1 on the CPU board. Any discrepancy between the two values will cause the CPU to display the Fault message at the end of Power-up testing.

Corrective action: Check chips U16 and U18 on the CPU board and U8 on the Mother board.

Fault # 013
PWM D/A conflicts with A/D (0V)

Occurs when: During Power-up testing, the CPU outputs 0V on the D/A, U18 pin 3 located on the CPU board. The output value is read by the A/D, U16 pin 1 on the CPU board. Any discrepancy between the two values will cause the CPU to display the Fault message at the end of Power-up testing.

Corrective action: Check chips U16 and U18 on the CPU board and U8 on the Mother board.

Fault # 014
PWM stop would not turn off

Occurs when: During Power-up testing, the PWM STP STATUS line, U5 pin 3, is checked to ensure that the DEAD STOP line, U6 pin 1, can enable the PWM controller. U6 pin 1 is toggled high, causing U5 pin 2 to be high. The failsafe is toggled, causing U5 pin 2 to be high. If the output of U5 pin 3 is high, the CPU will display the Fault message at the end of Power-up testing.

Corrective action: Check U5, U6, U14, and U16 on the Mother board.

Fault # 015
PWM stop would not turn on

Occurs when: During Power-up testing, the PWM STP STATUS line, U5 pin 3, is checked to ensure that the DEAD STOP line, U6 pin 1, can turn the PWM stop on by itself. The failsafe is toggled which causes U5 pin 1 to be high. U6 pin 1 is toggled low, causing U5 pin 2 to be low. If the output of U5 pin 3 is low, the CPU will display the Fault message at the end of Power-up testing.

Corrective action: Check U5, U6 U14, and U16 on the Mother board.

Fault # 016
Position is not calibrated

Occurs when: Calibration position parameters are stored in two addresses within chip U17 on the CPU board. During power-up testing and before an Injection is enabled, these two parameters are compared. If the parameters do not match, the Fault message will be displayed.

Corrective action: Re-calibrate the Powerhead position. If the error persists, replace chip U17 on the CPU board.

Fault # 017
Lost power head communications

Occurs when: During operation of the CT 9000, the CPU continually checks for signals from the powerhead. If a 3 second lapse occurs between receiving signals from the powerhead, the Fault message will be displayed.

Corrective action: Check the powerhead cable to ensure it is securely connected to the connectors in the rear of the powerhead and the rear of the electronics cabinet . If the Fault message continues, replace chips U13 and U14 on the Mother board and U1 on the Powerhead board.

Fault # 018
Lost console communications

Occurs when: This Fault message is only visible when two consoles are active. If this problem occurs while using a one-console system, the Fault Indicator light (the Injecting light) on the Powerhead will flash and the console keyboard will be locked-up.

Corrective action: Check the console cable to ensure it is securely connected to the connectors in the rear of the console and the rear of the electronics cabinet. If the console does not respond to these actions, replace the Console board.

Fault # 019
Flow rate error

Occurs when: The actual flow rate delivered by the syringe plunger is monitored by the CPU by using feedback from the motor encoder. When this flow rate is approximately 20% higher than the programmed flow rate, this Fault message will occur.

Corrective action: Replace chip U13 on the Mother board. If the problem persists, replace the Motor encoder.

Fault # 020
Motor moving wrong direction

Occurs when: Motor direction output from U14 pin 6 on the Mother board is incorrect. Fill syringe movement = high signal; Expel syringe movement = low signal.

Corrective action: Check to ensure J5 pins 1 and 2 on the Powerhead board are connected properly. Replace chips U14 and U13 on the Mother board.

Fault # 021
Syringe size sensing error

Occurs when: Face plate magnets are not sensed for a valid syringe size.

Corrective action: Check magnets. Replace sensor board in Powerhead.

Fault # 022
Heater thermistor tracking error

Occurs when: Heater Blanket thermistors are not at the approximate same level.

Corrective action: Replace the Heater Blanket. If the problem persists, replace U1 on the Powerhead board.

Fault # 023
Overheating error

Occurs when: If the Heater Blanket temperature is greater than 42 °C, this Fault message will be displayed.

Corrective action: Replace the Heater Blanket. If the problem persists, replace U1 on the Powerhead board.

Fault # 024
Power head communication error

Occurs when: The power pack indicates to the powerhead that the power pack communications packets are not valid.

Corrective action: Check U1 on the Powerhead board and U3 on the Mother board

Fault # 025
Power head flow rate error

Occurs when: The actual flow rate delivered by the syringe plunger is measured by the microcontroller in the powerhead. When this flow rate is approximately 25 % higher than the programmed flow rate, this Fault message will occur. This precaution acts as a backup to Fault # 19—Flow Rate Error.

Corrective action: Replace U1 on the Powerhead board.

Fault # 026
Ram past extend limit error

Occurs when: During plunger movement, the linear pot has moved past the calibrated 0 ml point.

Corrective action: Re-calibrate the position. Check the linear pot on the powerhead. Replace U1 on the Powerhead board.

Fault # 027
Ram past retract limit error

Occurs when: During plunger movement, the linear pot has moved past the calibrated 125/200 ml point.

Corrective action: Re-calibrate the position. Check the linear pot on the powerhead. Replace U1 on the Powerhead board.

Fault # 028
Unknown power head fault

Occurs when: The powerhead transmits garbled information to the power pack.

Corrective action: Replace the receiver U13 on the Mother board or the transmitter U3 on the Powerhead board.

Fault # 029
Pressure is not calibrated

Occurs when: Calibration pressure parameters are stored in two addresses within chip U17 on the CPU board. During power-up testing these two parameters are compared. Before an injection is enabled, the software performs a limit check on the stored calibration pressure parameters. If the parameters do not match, the Fault message will be displayed.

Corrective action: Re-calibrate the Powerhead pressure. If the error persists, replace chip U17 on the CPU board.

Fault # 030
Illegal state transition

Occurs when: The software has inadvertently moved into an erroneous state.

Corrective action: Cycle power to correct problem. If this problem persists, replace chips U10, U12, and U15 (RAM and ROM) on the CPU board.

Fault # 031
Bad power head communications

Occurs when: The power pack detects a number of invalid communications packets from the powerhead.

Corrective action: Replace U13 on the Mother board and/or U3 on the Powerhead board.

Fault # 032
No power head detected

Occurs when: During Power-up tests, the CPU checks for signals from the powerhead. If signals are not found, the Fault message will be displayed.

Corrective action: Check the powerhead cable to ensure it is securely connected to the connectors in the rear of the powerhead and the rear of the electronics cabinet . If the Fault message continues, replace chips U13 and U14 of the Mother board and U1 of the Powerhead board.

Fault # 033
Bad EEPROM detected on CPU Board

Occurs when: During Power-up testing, the CPU performs a Write function to the EEPROM, chip U17. If this cannot be completed, the CPU displays the Fault message at the end of Power-up testing.

Corrective action: Replace the EEPROM U17 on the CPU board.

Fault # 035
Software error

Occurs when: A Power-up Fault message is called to be displayed when no Power-up Faults have been detected by the CPU.

Corrective action: Cycle power to correct problem. If this problem persists, replace chips U10 and U12 on the CPU board.

Fault # 036
RAM test failed

Occurs when: This Fault message will be displayed when the RAM R/W test performed by the CPU during Power-up testing has failed.

Corrective action: Replace the RAM chip U15.

Fault # 037
ROM test failed

Occurs when: This Fault message will be displayed when the EPROM (U10) Cyclic Redundancy Check (CRC) has failed.

Corrective action: Replace U10.

Fault # 038
No encoder counts detected

Occurs when: This Fault message will be display when the encoder counts are not being detected by the CPU even though a voltage is being delivered to the motor.

Corrective action: Check the motor, connector J5 on the powerhead and
Fuse 2 on the Mother board.

Fault # 039
Linear pot. tracking error

Occurs when: This Fault message will be displayed when the linear pot position on the RAM does not match the motor encoder position.

Corrective action: Ensure the linear pot is connected securely to J7 and that the wiper on the linear pot is attached to the ball screw.

Fault # 041
Overvolume error detected

Occurs when: This Fault message will by displayed when the volume delivered exceeds programmed volume by 2 ml.

Corrective action: Re-calibrate position. If the problem persists, check the brake circuitry on the Mother board consisting of U15, Q2, and Q3.

Fault # 042
Console key closed on powerup

Occurs when: During Power-up testing, all console keys must be in the opened position. Otherwise, this Fault message will be displayed by the CPU at the end of Power-up testing.

Corrective action: Ensure all keys are released during Power-up testing. If the problem persists, replace the Console keyboard.

Fault # 043
Power head key closed on powerup

Occurs when: During Power-up testing, all powerhead keys must be in the opened position. Otherwise, this Fault message will be displayed by the CPU at the end of Power-up testing.

Corrective action: Ensure all keys are released during Power-up testing. If the problem persists, replace the Powerhead keyboard.

RE-ASSEMBY OF THE POWERHEAD

Two critical dimensions and one screw torque necessary for the re-assemby process of the Powerhead are as follows:

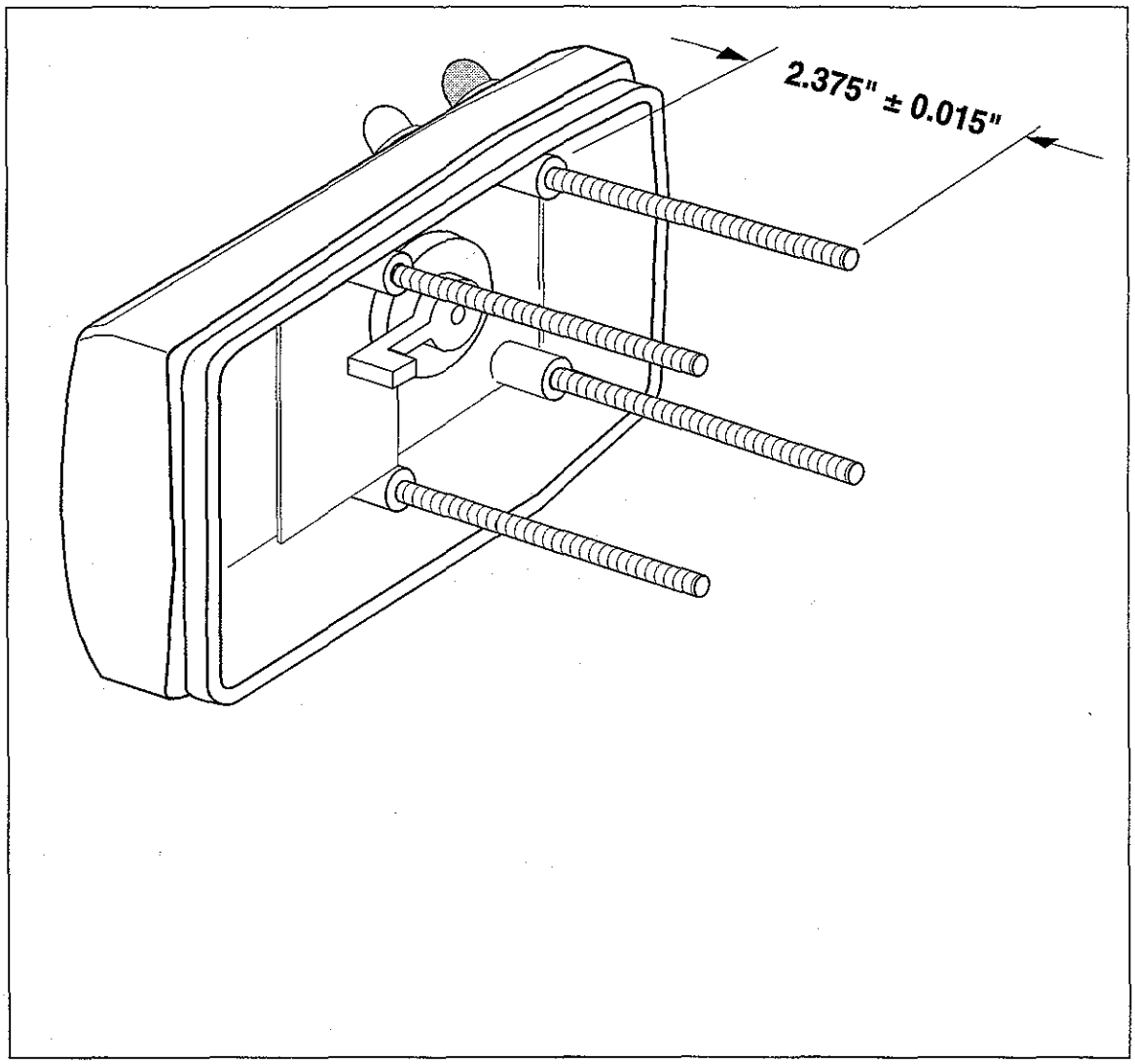


Figure 4-3. Critical Dimension of End Bracket Assembly

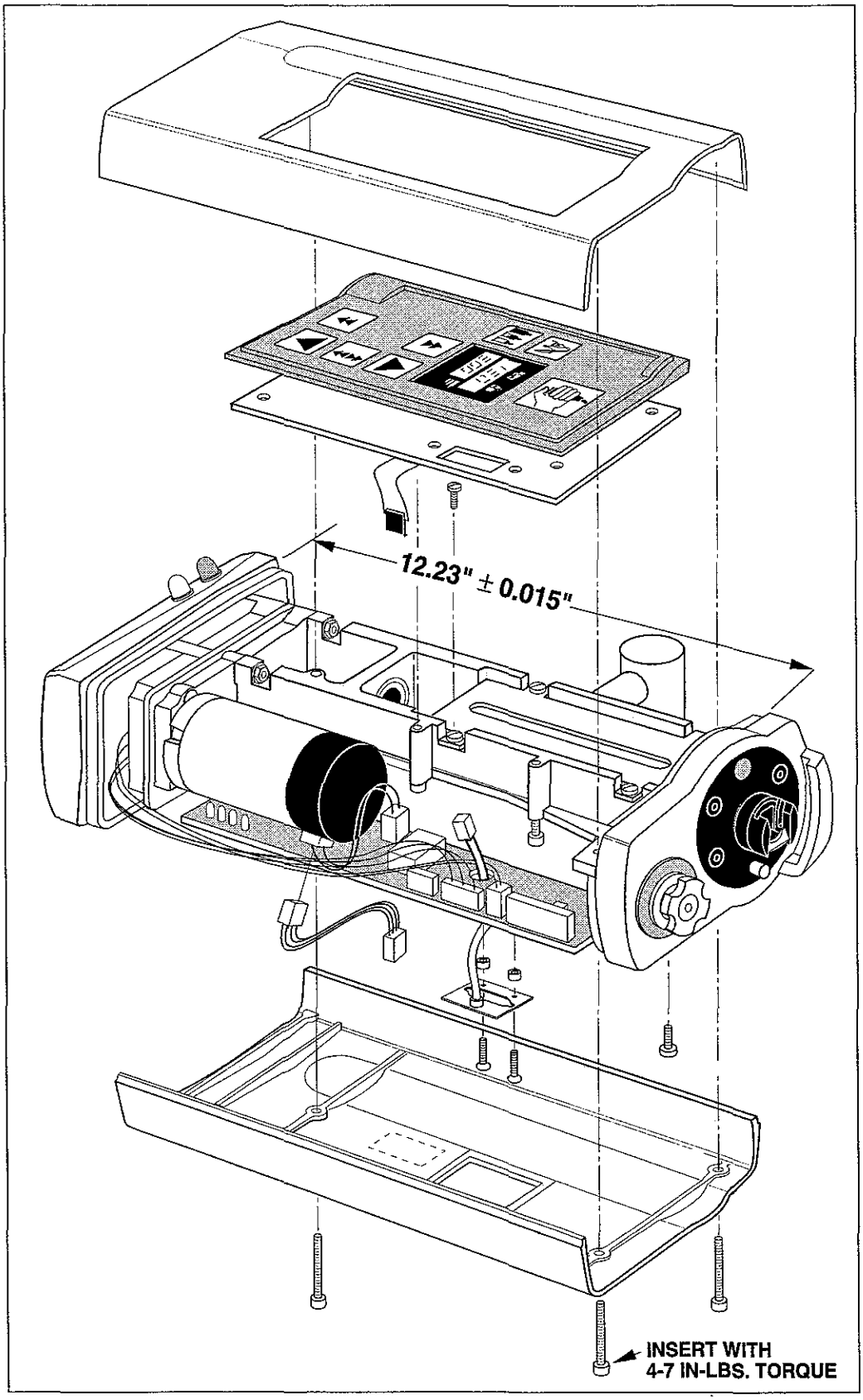


Figure 4-4. Critical Dimension of Powerhead Assembly

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5 CALIBRATION

These calibration procedures are for field calibration of a properly working unit. In order to calibrate the unit correctly, the service technician must have some familiarity with the operational procedures of the injector such as loading a syringe into the unit, filling the syringe, setting the protocol parameters and injecting. For more information on these procedures refer to the Operator's Manual.

TOOLS REQUIRED

Screwdriver to remove the Power Pack (i.e., Electronics Cabinet) cover
Screwdriver to remove face plate
Pressure Gage Assembly (LF P/N 600867)
Water
Water container to collect expelled water

PLACING UNIT IN CALIBRATION MODE

In order to calibrate the unit, Switch 1 of the Power Pack's CPU board must be re-configured.

1. Turn off power to the unit by moving the toggle switch located in the rear of the Power Pack to the "off" position.
2. Remove the cover from the Power Pack. Refer to the Parts section for an exploded drawing of the Power Pack.
3. Move position 1 of SW1 of the CPU board to the "off" position. See Figure 1-4 of the Parts section for location of Switch 1.
4. Power the unit by turning the toggle switch to the "on" position and pushing the control console power switch once to return power. The unit is now in the Calibration Mode.

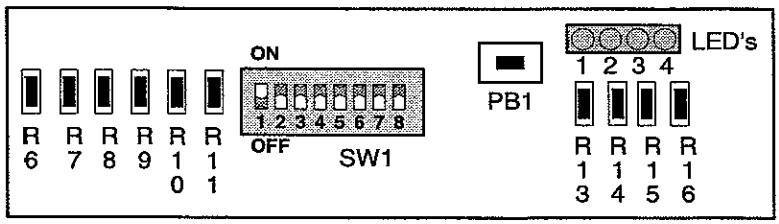

Figure 5-1 SW1 of the CPU Board

FACTORY CALIBRATION

From the Factory Calibration Screen you can Enable and Disable Faceplates. (Refer to Figure 5-1a).

NOTE: The injector will display an error message if an injection is attempted with a disabled faceplate. If a faceplate is disabled all calibration data for that faceplate is lost.

1 Place the unit in the Calibration Mode (Refer to the previous Section—*Placing Unit in Calibration Mode*). Remove the Pressure Plate Assembly from the powerhead.

❶ To activate the Factory Calibration Screen the appropriate password must entered. The password is activated by pressing a key sequence. From the top key count down to key 4 and proceed as follows:

Press key 4, then key 5, then key 4, then key 6.

The Factory Calibration Screen will be displayed.

❷ Press the desired Faceplate key to Enable or Disable. Your selection will toggle under the 'Enable' column either YES or NO.

2 Press the [Exit] key when selection is completed.

3 Move position 1 of SW1 on the CPU board to the "on" position. Then press the [Exit] key again to return to normal operation..

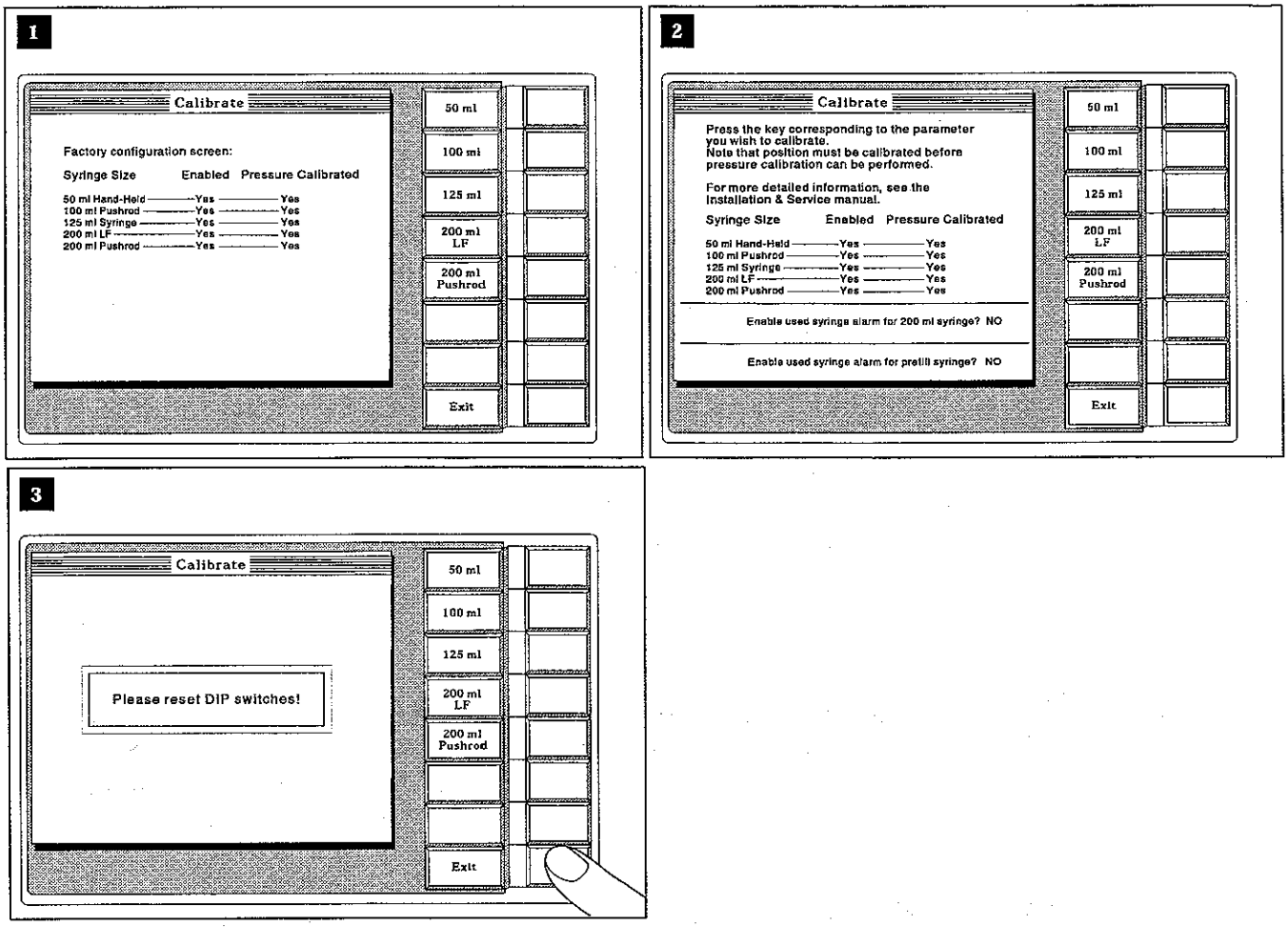
1
Calibrate
Factory configuration screen:
Syringe Size Enabled Pressure Calibrated
50 ml Hand-Held Yes Yes
100 ml Pushrod Yes Yes
125 ml Syringe Yes Yes
200 ml LF Yes Yes
200 ml Pushrod Yes Yes
50 ml
100 ml
125 ml
200 ml LF
200 ml Pushrod
Exit
2
Calibrate
Press the key corresponding to the parameter you wish to calibrate.
Note that position must be calibrated before pressure calibration can be performed.
For more detailed information, see the Installation & Service manual.
Syringe Size Enabled Pressure Calibrated
50 ml Hand-Held Yes Yes
100 ml Pushrod Yes Yes
125 ml Syringe Yes Yes
200 ml LF Yes Yes
200 ml Pushrod Yes Yes
Enable used syringe alarm for 200 ml syringe? NO
Enable used syringe alarm for prefill syringe? NO
50 ml
100 ml
125 ml
200 ml LF
200 ml Pushrod
Exit
3
Calibrate
Please reset DIP switches!
50 ml
100 ml
125 ml
200 ml LF
200 ml Pushrod
Exit

Figure 5-1a

POSITION CALIBRATION

NOTE: The Position Calibration must be performed prior to performing the Pressure Calibration.

Refer to Figure 5-2.

1. Place the unit in the Calibration Mode (Refer to the Section—*Placing Unit in Calibration Mode*). Remove the Pressure Plate Assembly from the powerhead.

2. Press [Calibrate Position].

3.
   1. Using the Manual Control knob, incrementally move the ram to align its top to be flush with the face plate (±0.010"). The use of a straight edge will allow the technician to view the alignment easier.
   2. Press the 'Set' key. The 'Set' key will momentarily turn white to indicate a successful input.

4.
   1. Press the [Fast] key and [Forward] key to advance the ram to extend 4.590" (±0.010") from the face plate.
   2. Press the 'Set' key again. The CT 9000 will display the prompt "Position calibration completed! Press EXIT to continue."

5. Press the [Exit] key to continue with Pressure Calibration.

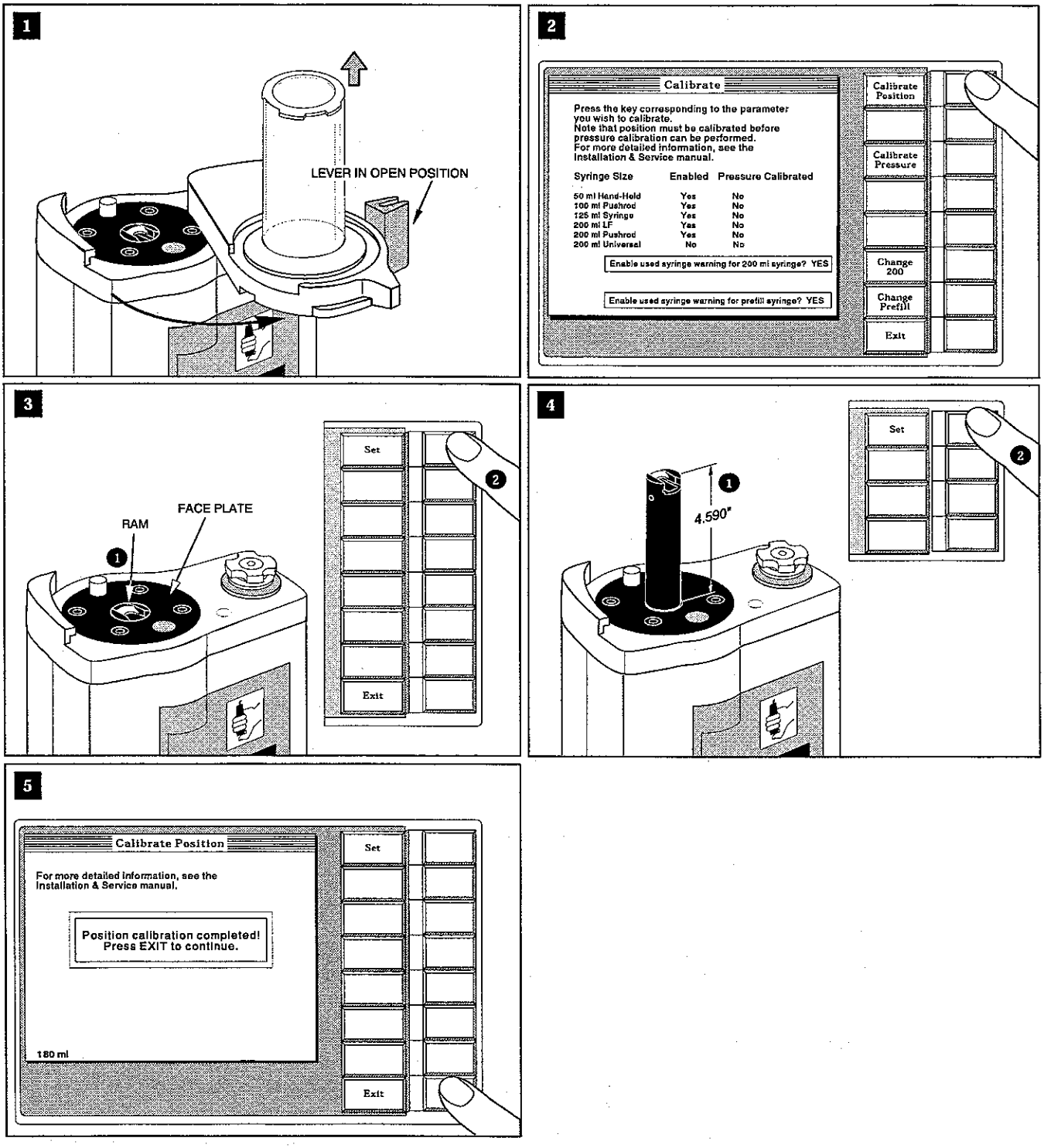

Figure 5-2 Position Calibration

PRESSURE CALIBRATION FOR ALL SYRINGE FACE PLATES

Use the following procedures to properly calibrate the CT 9000 Digital Injection System for each syringe size face plate.

NOTE: During the calibration procedure the console will display the syringe size face plates that have been "enabled" for your injector. See Figure 5-3. You must calibrate the system for all enabled syringe size face plates using the following procedures. If you fail to calibrate for all enabled syringe size face plates, the system will not function and the console will display Fault #29: "Pressure is not calibrated".

PRESSURE CALIBRATION FOR 200 ML SYRINGE USE WITH 125 ML COMPENSATION

NOTE: Prior to starting the Pressure Calibration procedure, the Position Calibration must be performed.

Refer to Figure 5-3.

1 With unit still in the Calibration Mode, install a 200 ml Pressure Plate Assembly onto the powerhead. Fill the syringe with tap water and install the Pressure Gage Assembly (P/N 600867). Remove all air from the syringe and tubing. Turn the Pressure Gage valve approximately 1/4 of a turn from the closed position to simulate a # 8 butterfly needle.

2 Press [Calibrate Pressure].

3 Connect the oscilloscope ground to the anode of D8 and the probe to the cathode of D8 located on the Mother board. Set oscilloscope to 5v/div., 2µs/div., positive trigger.

4 Press [100 psi] and adjust R80 located on the Mother board (R27 on Rev G and earlier boards) so that the servo frequency is 100 KHz (10µs period ±0.5µs).

5

1. Refill the syringe and press [300 psi] to calibrate the unit for delivery at 300 psi. *The injection will be enabled during these procedures.*
2. While viewing the gage, use the [⇧] and [⇩] keys to obtain the 300 psi pressure. If this pressure cannot be achieved, slightly close the valve to further restrict fluid flow. Repeat this step if the injection is completed before 300 psi can be reached.

6 Once the pressure is stabilized at 300 psi, press the [Set Pressure] key.

7 Refill the syringe and repeat Steps 5 and 6 for [200 psi] and [100 psi].

Continued on next even page...

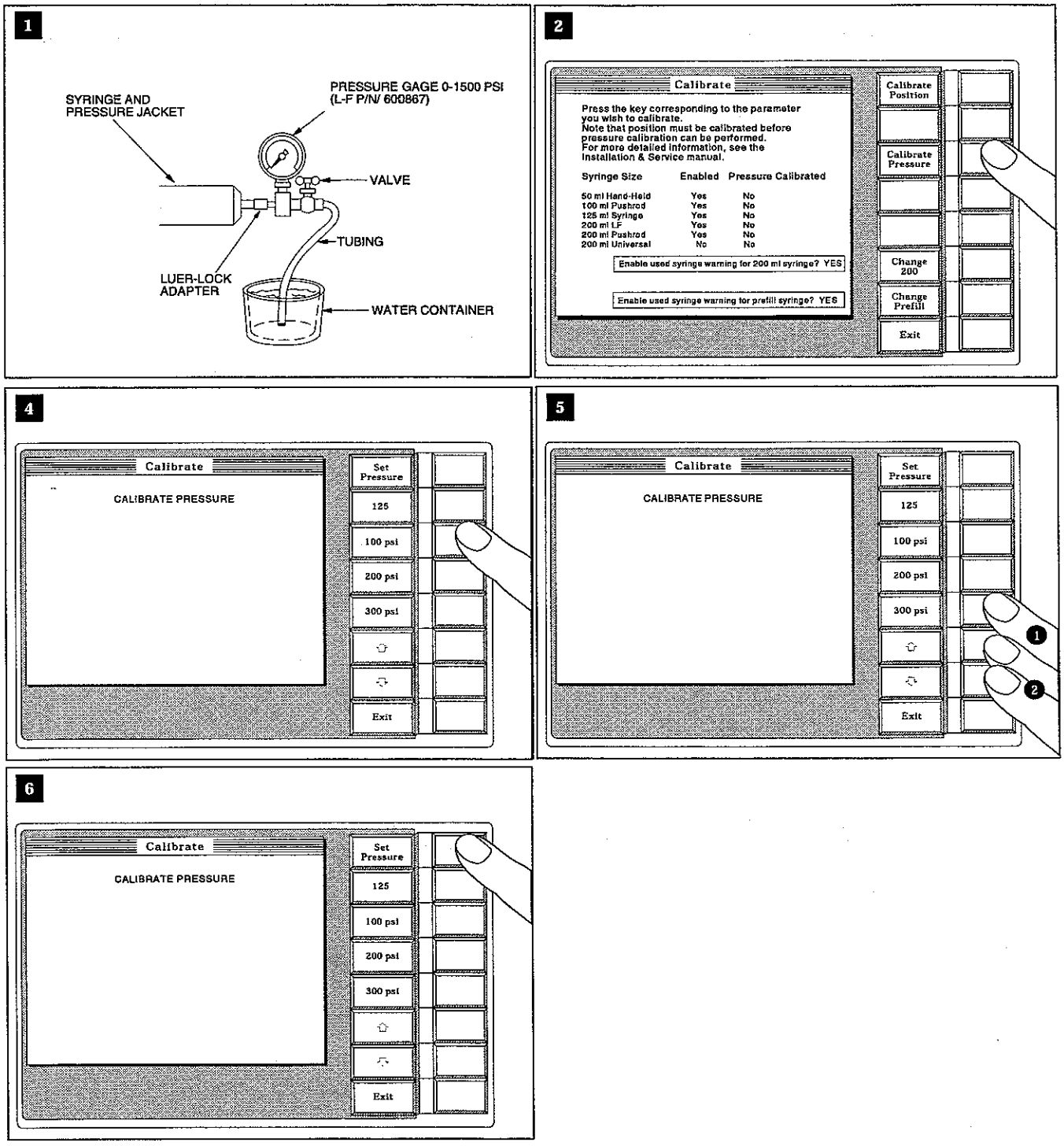

Fig. 5-3 200 mL Pressure Calibration

8 Remove the 200 ml Pressure Plate Assembly and Pressure Gage Assembly, *leaving the valve in the same position.* Install a 125 ml Pressure Plate Assembly onto the powerhead. Fill the syringe with tap water and install the Pressure Gage Assembly (P/N 600867). Remove all air from the syringe and tubing.

9 Press the [125] key and view the gage. If the average value of the pressure is not within ±15 psi of 200 psi, then select switch settings of SW1 on the CPU board as shown in the following table.

SW1 Pin			
3	4	5	Δ PSI
OFF	OFF	OFF	+40
OFF	OFF	ON	+30
ON	OFF	OFF	+20
OFF	ON	OFF	+10
ON	ON	ON	DEFAULT
ON	OFF	ON	-10
ON	ON	OFF	-20
OFF	ON	ON	-30

10 Refill the syringe and press the [125] key and confirm the SW1 settings enable the 200 psi pressure to be met.

11 Press the [Exit] key. The CT 9000 will prompt you to return position 1 of SW1 back to the "on" position.

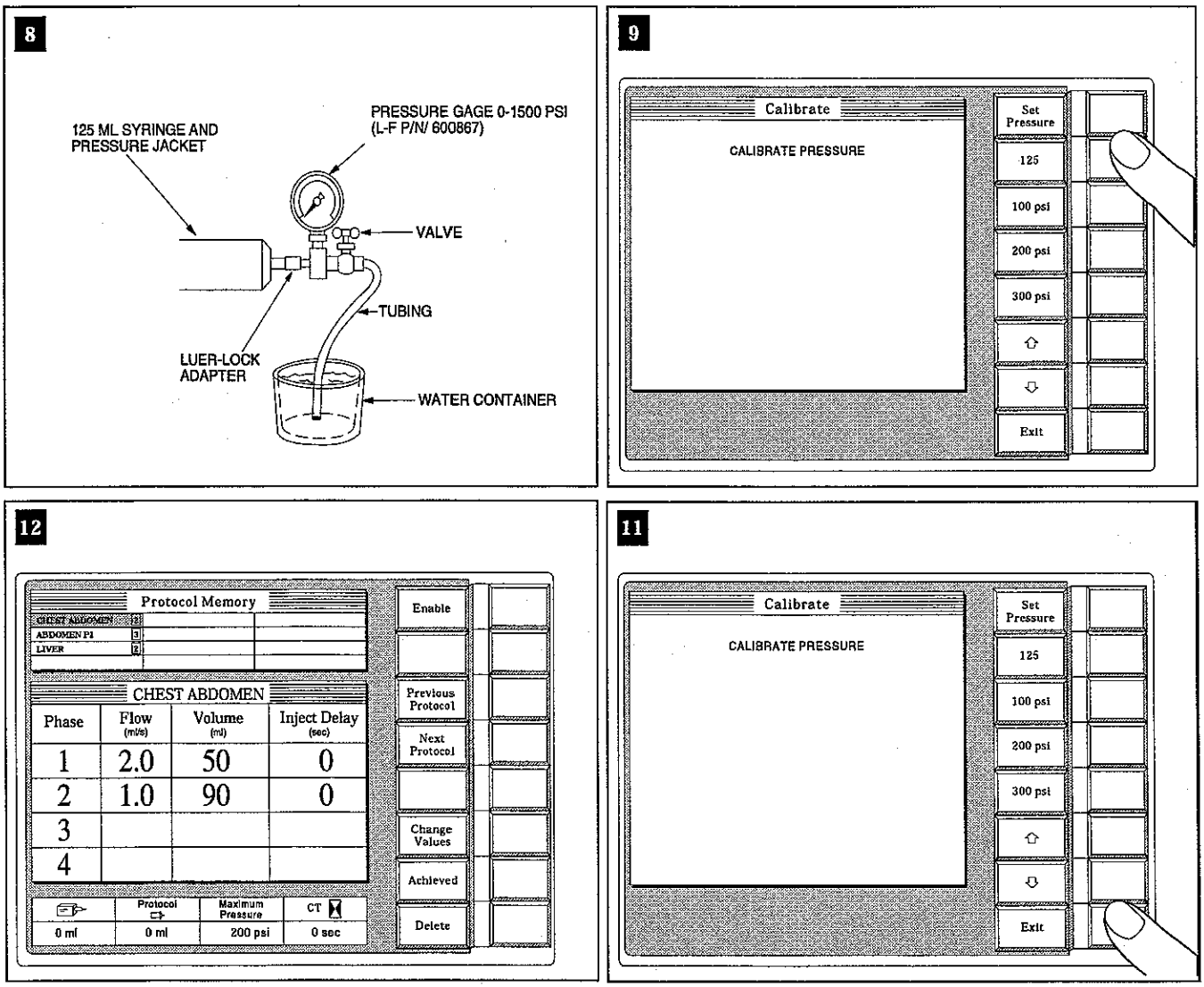

Fig. 5-3 200 mL Pressure Calibration (Continued)

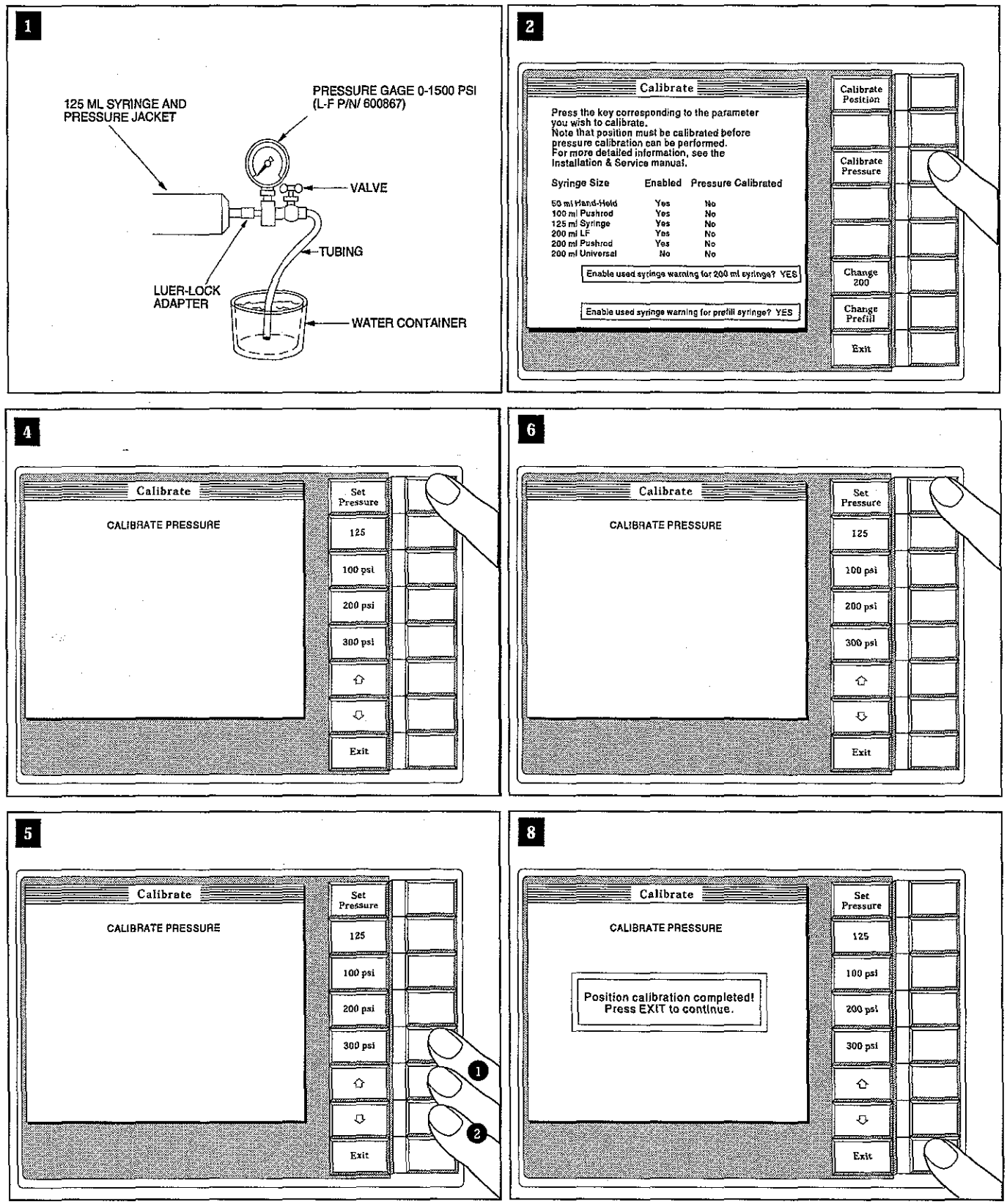

Fig. 5-4 200 mL Pressure Calibration 200 mL Pushrod, 100 mL Pushrod, and 30-50 Handheld

PRESSURE CALIBRATION FOR 200 ML PUSHROD SYRINGE

NOTE: *Prior to starting the Pressure Calibration procedure, the Position Calibration must be performed.*

Refer to Figure 5-4.

1 With unit still in the Calibration Mode, install a 200 ml Pushrod Pressure Plate Assembly onto the powerhead. Fill the syringe with tap water and install the Pressure Gage assembly (P/N 600867). Remove all air from the syringe and tubing. Turn the Pressure Gage valve approximately 1/4 of a turn from the closed position to simulate a # 8 butterfly needle.

2 Press [Calibrate Pressure].

NOTE: *Only perform steps 3 and 4 below if you have not already completed these steps during a previous syringe calibration.*

3 Connect the oscilloscope ground to the anode of D8 and the probe to the cathode of D8 located on the Mother board. Set oscilloscope to 5v/div., 2µs/div., positive trigger.

4 Press [100 psi] and adjust R80 located on the Mother board (R27 on Rev G and earlier boards) so that the servo frequency is 100 KHz (10µs period ±0.5µs).

5

1. Refill the syringe and press [200 psi] to calibrate the unit for delivery at 200 psi. *The injection will be enabled during these procedures.*
2. While viewing the gage, use the [⇧] and [⇩] keys to obtain the 200 psi pressure. If this pressure cannot be achieved, slightly close the valve to further restrict fluid flow. Repeat this step if necessary.

6 Once the pressure is stabilized at 200 psi , press the [Set Pressure] key.

7 Refill the syringe and repeat Steps 5 and 6 for [100 psi].

8 Press the [Exit] key. The CT 9000 will prompt you to return position 1 of SW1 back to the "on" position.

9 Once you have completed calibration for the 200 ml Pushrod syringe, continue to the next calibration procedure, "Pressure Calibration for 100 ml Pushrod Syringe".

PRESSURE CALIBRATION FOR 100 ML PUSHROD SYRINGE

NOTE: *Prior to starting the Pressure Calibration procedure, the Position Calibration must be performed.*

Refer to Figure 5-4.

1 With unit still in the Calibration Mode, install a 100 ml Pushrod Pressure Plate Assembly onto the powerhead. Fill the syringe with tap water and install the Pressure Gage assembly (P/N 600867). Remove all air from the syringe and tubing. Turn the Pressure Gage valve approximately 1/4 of a turn from the closed position to simulate a # 8 butterfly needle.

2 Press [Calibrate Pressure].

NOTE: *Only perform steps 3 and 4 below if you have not already completed these steps during a previous syringe calibration.*

3 Connect the oscilloscope ground to the anode of D8 and the probe to the cathode of D8 located on the Mother board. Set oscilloscope to 5v/div., 2µs/div., positive trigger.

4 Press [100 psi] and adjust R80 located on the Mother board (R27 on Rev G and earlier boards) so that the servo frequency is 100 KHz (10µs period ±0.5µs).

5

1. Refill the syringe and press [300 psi] to calibrate the unit for delivery at 300 psi. *The injection will be enabled during these procedures.*
2. While viewing the gage, use the [⇧] and [⇩] keys to obtain the 300 psi pressure. If this pressure cannot be achieved, slightly close the valve to further restrict fluid flow. Repeat this step if necessary.

6 Once the pressure is stabilized at 300 psi , press the [Set Pressure] key.

7 Refill the syringe and repeat Steps 5 and 6 for [200 psi] and [100 psi].

8 Press the [Exit] key. The CT 9000 will prompt you to return position 1 of SW1 back to the "on" position.

9 Once you have completed calibration for the 100 ml Pushrod syringe, continue to the next calibration procedure, "Pressure Calibration for 30-50 ml Hand-Held Syringe".

PRESSURE CALIBRATION FOR 30-50 ML HAND-HELD SYRINGE

NOTE: *Prior to starting the Pressure Calibration procedure, the Position Calibration must be performed.*

Refer to Figure 5-4.

1 With unit still in the Calibration Mode, install a 30-50 ml Hand-Held Pressure Plate Assembly onto the powerhead. Fill the syringe with tap water and install the Pressure Gage assembly (P/N 600867). Remove all air from the syringe and tubing. Turn the Pressure Gage valve approximately 1/4 of a turn from the closed position to simulate a # 8 butterfly needle.

2 Press [Calibrate Pressure].

NOTE: *Only perform steps 3 and 4 below if you have not already completed these steps during a previous syringe calibration.*

3 Connect the oscilloscope ground to the anode of D8 and the probe to the cathode of D8 located on the Mother board. Set oscilloscope to 5v/div., 2µs/div., positive trigger.

4 Press [100 psi] and adjust R80 located on the Mother board (R27 on Rev G and earlier boards) so that the servo frequency is 100 KHz (10µs period ±0.5µs).

5

1. Refill the syringe and press [300 psi] to calibrate the unit for delivery at 300 psi. *The injection will be enabled during these procedures.*
2. While viewing the gage, use the [⇧] and [⇩] keys to obtain the 300 psi pressure. If this pressure cannot be achieved, slightly close the valve to further restrict fluid flow. Repeat this step if necessary.

6 Once the pressure is stabilized at 300 psi , press the [Set Pressure] key.

7 Refill the syringe and repeat Steps 5 and 6 for [200 psi] and [100 psi].

8 Press the [Exit] key. The CT 9000 will prompt you to return position 1 of SW1 back to the "on" position.

9 Once you have completed calibration for each syringe size face plate, calibration of the unit is complete. The unit will display the Protocol Memory screen. Remove the oscilloscope probes and replace the Power Pack cabinet cover.

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6 MAINTENANCE

A checklist is included in the front pocket of this manual. Fill in the necessary information on a copy of the checklist. File the checklist according to the Serial Number or Hospital in order to maintain a Preventive Maintenance history of the unit.

QUALIFICATIONS

Preventive Maintenance on any unit must be performed by a Qualified Technician who is completely familiar with the use and operation of the Injector, trained by a Liebel-Flarsheim instructor in the area of preventive maintenance for the Injector and familiar with the content of the Operator's Manual and the Installation and Service Manual.

MAINTENANCE SCHEDULE

Preventive Maintenance should be performed every 12 months.

LEAKAGE AND GROUND CONTINUITY CHECKS

1. With the unit plugged in, check the electrical leakage with a leakage meter, or use an AC voltmeter with the attenuation network shown in Figure 6-1. The leakage should be less than 100 microamperes. If higher, check for the cause and repair.

WARNING!
If system leakage remains above 100 microamperes, do not use the injector as it may be a shock risk for the operator. Contact an authorized service representative.

2. Disconnect the leakage test equipment.

3. Check the ground impedance as follows: Unplug the power cord. Using an ohmmeter, verify continuity between exposed metal parts of the powerhead, console, and power pack and the ground pin on the power plug.

DANGER!
If ground continuity is nonexistent, do not use the injector, contact an authorized service representative. Failure to follow this instruction can result in serious injury.

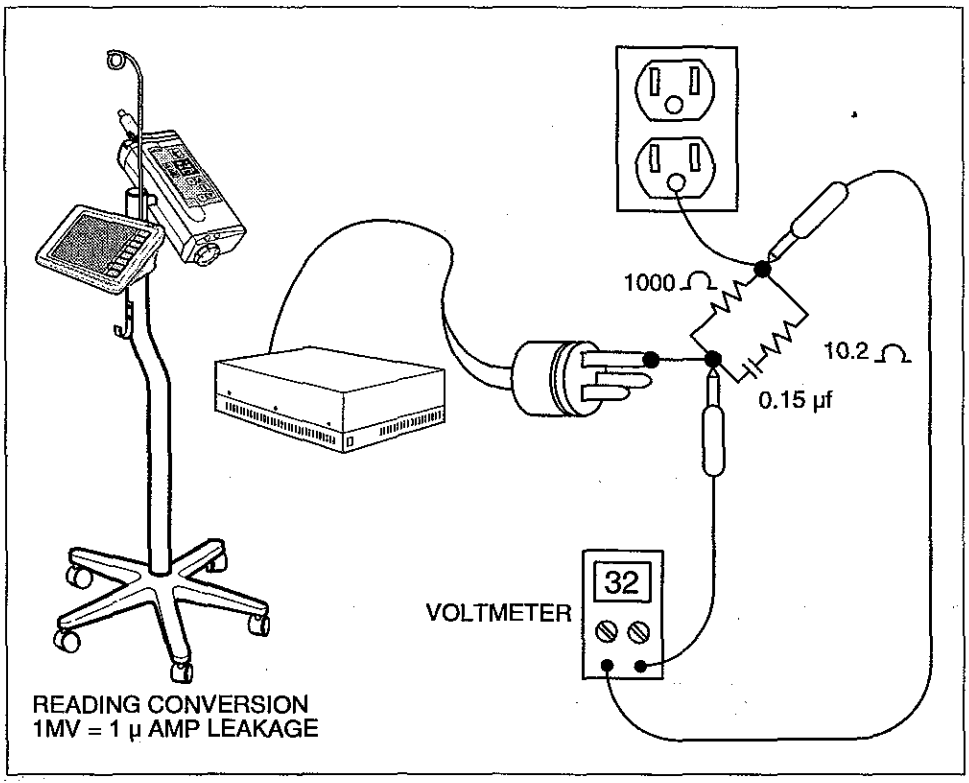


Figure 6-1. Leakage Test Set-up (Unit is plugged in)

EXTERIOR OF COMPONENTS

Perform Steps 1 through 5 of the *Installation Procedure* located in Chapter 2.

POWER-UP CHECK

1. Turn on the unit by first toggling the power pack's power switch located on the rear of the cabinet. Then push the console power switch located on the left-handed side of the console.
2. Verify that the white light on the power head turns on briefly in approximately 10 seconds. The LED located on the power pack and on the upper right hand corner of the console will glow and the start up screen will appear in approximately 18 seconds. Verify the 'Registered to' name is correct.
3. Make sure the start up menu (refer to Chapter 2) appears approximately 15 seconds after start up screen. Enter the control panel from the start up menu and verify that the time and date displays are correct.
4. Exit the control panel. The enable screen should appear.

POWERHEAD/PRESSURE JACKET

1. Remove the syringe from the pressure jacket in order to fully inspect the pressure jacket. As a preventive measure, replace the pressure jacket once a year.

WARNING!
Syringe pressure jackets must withstand pressures generated during injection delivery. Defective jackets may shatter or explode under these conditions. Always inspect pressure jacket closely before using injector. Rotate the pressure jacket while viewing all areas; look for stress cracks (around the front or at the shoulder area), discard any pressure jacket exhibiting signs of stress, crazing lines or cracks. The use of such parts may cause injury and/or an aborted injection.

2. Inspect the ram, seals and heater connector to ensure they are free from dried contrast. If necessary, clean as directed in the section *Cleaning and Lubrication.*
3. Check the powerhead pivot assembly to ensure that the pivot is operating properly. Rotate the powerhead 180° to the inverted position. If the pivot allows the powerhead to rotate to the non-inverted position, tighten the pivot assembly screw as shown in Figure 3-2b located in the Parts section. After tightening the screw, ensure that the pivot still allows the powerhead to rotate.
4. Turn on the injector. Check the operation of the powerhead keys. Make sure the keys are operating freely and not sticking.
5. Check that the ram correctly picks up the syringe plunger. Also check for unusual powerhead noise while running the ram.
6. Check operation of the pressure jacket plate latch for each type of face plate. Open and close the plate. It should operate smoothly without interference or binding. Check for contrast build up. If necessary, clean as directed in the section *Cleaning and Lubrication.*
7. Check the digital display for correct readings of volume and face plate size.

KEYBOARD CONSOLE

1. Check that the Console keys and Remote Start switch is operating properly and not sticking.

ELECTRONICS CABINET

1. Check that the LED on the front of the cabinet is working properly

FLOW RATE CHECK

NOTE: For the flow rate checks below, install the pressure kit used during the calibration procedures in Chapter 5. Turn the valve 1/2 turn open.

1. Enter an Injection with the following parameters, for available faceplates.

200 ml Pressure Plate Assembly:
Flow Rate: 9.9 ml/sec
Volume: 195 ml
Pressure Limit: 300 psi

125 ml Pressure Plate Assembly:
Flow Rate: 9.9 ml/sec
Volume: 123 ml
Pressure Limit: 300 psi

200 ml Pushrod Pressure Plate Assembly:
Flow Rate: 9.9 ml/sec
Volume: 195 ml
Pressure Limit: 150 psi

100 ml Pushrod Pressure Plate Assembly:
Flow Rate: 9.9 ml/sec
Volume: 95 ml
Pressure Limit: 300 psi

30-50 ml Hand-Held Pressure Plate Assembly:
Flow Rate: 7.0 ml/sec
Volume: 30 ml
Pressure Limit: 300 psi

Enable the injection without saving.

2. Verify that the display will ask if air has been evacuated.
3. Press the [Yes] key. Expected Duration shall be between 4 and 20 seconds, depending on the type of pressure plate used.

200 ml Pressure Plate Assembly:
Expected Duration: 20 sec

125 ml Pressure Plate Assembly:
Expected Duration: 12 sec

200 ml Pushrod Pressure Plate Assembly:
Expected Duration: 20 sec

100 ml Pushrod Pressure Plate Assembly:
Expected Duration: 10 sec

30-50 ml Hand-Held Pressure Plate Assembly:
Expected Duration: 4 - 7 sec

4. Verify the Powerhead's Enable light is illuminated.
5. Press the [Start] key. Verify that the "Inject Time", rotating wheel, and "Volume Delivered" are tracking correctly and that the Powerhead's Injecting light is illuminated.
6. When the "Achieved Values" screen is displayed, verify the Time, Flow, and Volume results are within tolerances as follows: The pressure should be less than 300 psi in each case.

200 ml Pressure Plate Assembly:

Time = 20 ± 1 second

Flow = 9.9 ± 0.2 ml/sec

Volume = 195 ± 2 ml

125 ml Pressure Plate Assembly:

Time = 12.5 ± 1 second

Flow = 9.9 ± 0.2 ml/sec

Volume = 123 ± 2 ml

200 ml Pushrod Pressure Plate Assembly:

Time = 20 ± 1 second

Flow = 9.9 ± 0.2 ml/sec

Volume = 195 ± 2 ml

100 ml Pushrod Pressure Plate Assembly:

Time = 9.5 ± 1 second

Flow = 9.9 ± 0.2 ml/sec

Volume = 195 ± 2 ml

30-50 ml Hand-Held Pressure Plate Assembly:

Time = 4.25 ± 1 second

Flow = 7.0 ± 0.2 ml/sec

Volume = 30 ± 2 ml

7. Run a second injection with the following parameters:

200 ml or 125 ml Pressure Plate Assembly:

Flow Rate: 3.0 ml/sec

Volume: 99 ml

Verify the "Achieved Values":

Time = 33 +2/-1 seconds

Flow = 3.0 ± 0.1 ml/sec

Volume = 99 ± 2 ml

8. Run a third injection with the following parameters:

200 ml or 125 ml Pressure Plate Assembly:

Flow Rate: 0.1 ml/sec

Volume: 10 ml

Verify the "Achieved Values":

Time = 1:40 ± 30 seconds

Flow = 0.1 ± 0.1 ml/sec

Volume = 10 ± 1 ml

PRESSURE LIMIT CHECK

For the following checks install the pressure kit used during the pressure calibration procedures in Chapter 5. Start with the valve open 1/4 turn and follow the directions given in each case.

1. Enter an Injection with the following parameters, for available Pressure Plates.

   200 ml Pressure Plate Assembly:
   Flow Rate: 8 ml/sec
   Volume: 190 ml
   Pressure Limit: 200 psi

   125 ml Pressure Plate Assembly:
   Flow Rate: 8 ml/sec
   Volume: 123 ml
   Pressure Limit: 200 psi

2. Fill the syringe and purge air from the system.
3. With the pressure gauge assembly connected initiate the procedure.
4. Slowly turn the valve closed until the injector reports pressure limit reached. Verify the gauge displays 200 PSI ± 25 PSI while the injector is running pressure limited.

CLEANING THE UNIT

PRESSURE SLEEVE AND PLATE

On a daily basis, move the ram to the retract position and wipe out the inside of the pressure sleeve with a damp, lint-free towel.

WARNING! DO NOT AUTOCLAVE PRESSURE SLEEVE
This type of pressure sleeve must not be autoclaved.

The entire syringe plate and pressure sleeve should be placed or soaked in warm water with a mild soap to remove any hardened contrast. *Use of solvents or disinfectant cleaners may damage the pressure sleeve.* This procedure is also helpful if the locking lever is hard to rotate. Refer to the Operator's Manual for instructions on how to remove each pressure plate.

CONTROL CONSOLE

The control console screen may be dusted by using a lint-free cloth. The key pad of the control console may be cleaned by using an all-purpose household cleaner. Spray the cleaner on the cloth, then gently buff the key pads clean.

POWER PACK

Clean the exterior of the power pack (i.e., electronics cabinet) by spraying a cloth with an all-purpose household cleaner, then gently wipe clean.

CUSTOMER INTERFACE

Answer all customer questions regarding operation or use of the equipment. Discuss any areas of concern the customer may have about the unit.

MALLINCKRODT

Liebel-Flarsheim

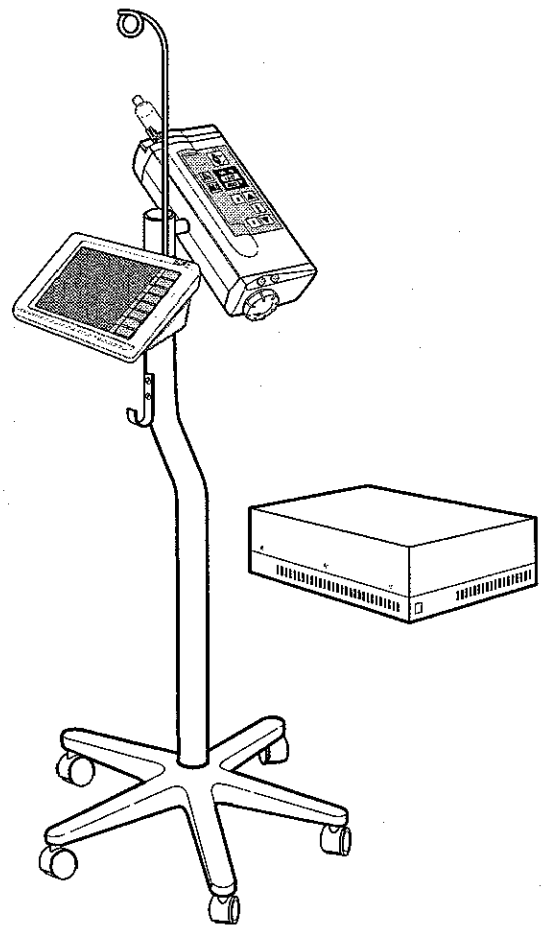
2111 E. GALBRAITH ROAD CINCINNATI, OHIO 45237-1640

MALLINCKRODT

Liebel-Flarsheim

CT 9000® ADV

Digital Injection System

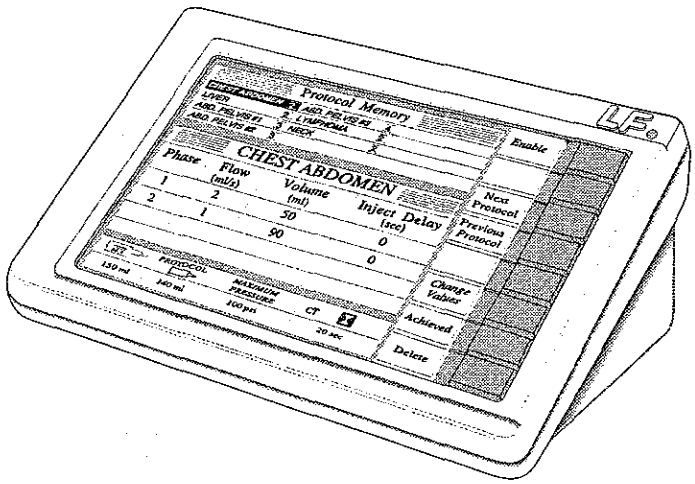


PARTS MANUAL

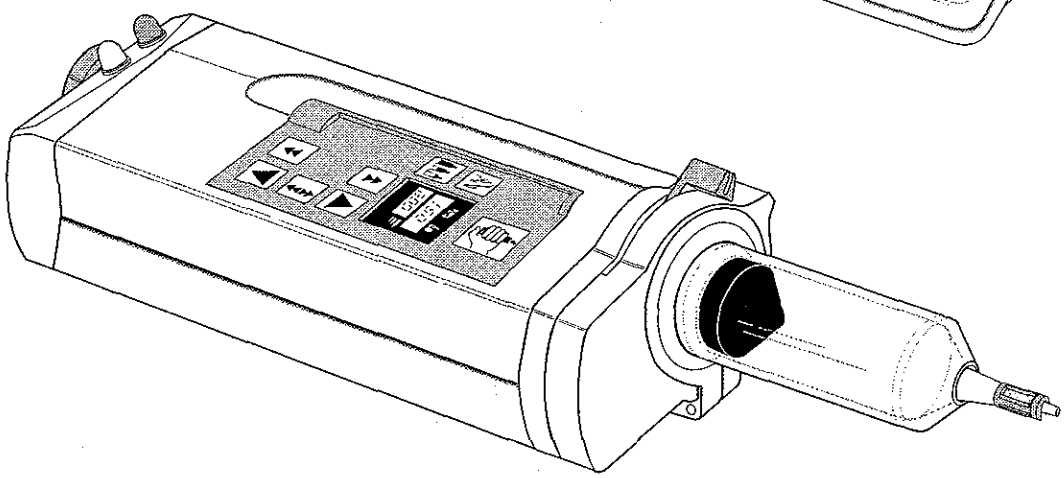
800961-C

Major Components

Console
Section IV



Powerhead
Section III



Power Pack Assembly
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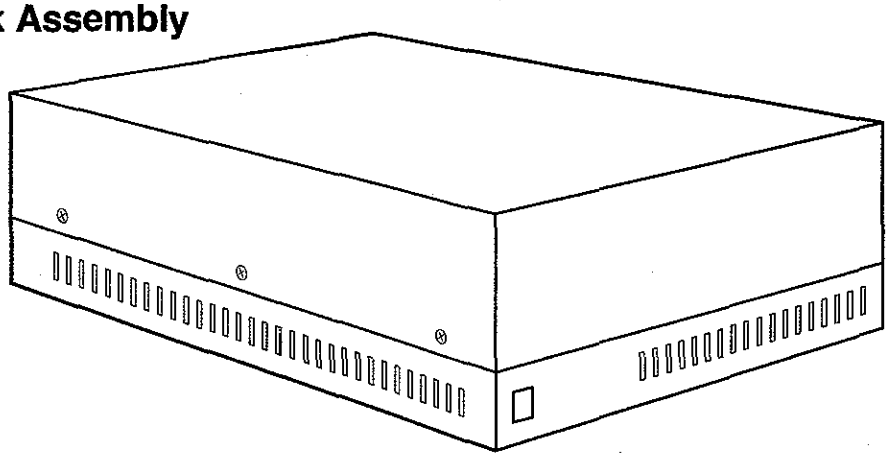

INTRODUCTION

GENERAL

The following is intended to facilitate the procurement of parts applicable to the CT 9000® ADV Digital Injection System with a 115-volt chassis.

PRODUCT STRUCTURE DIAGRAM

The Product Structure Diagram, on page iv is a tree-structured diagram listing all major assemblies under the three main components constituting the CT 9000® ADV Digital Injection System. The three main components are:

- Power Pack Assembly
- Powerhead
- Console

GROUP ASSEMBLY PARTS LISTS

The Group Assembly Parts List, Sections 1 through 4, consists of the complete end item, divided into its major assemblies, subassemblies, and component parts. See Table of Contents. It has five columns: Figure and Index Number, Part Number, Description, Units per Assembly and Component Designator (used to highlight individual components on printed circuit boards.)

FIGURE & INDEX NUMBER COLUMN

The first number in this column, preceding a dash, indicates the figure number, and the number following the dash indicates the index for that particular illustration.

PART NUMBER COLUMN

This column contains the identification number of the assembly, subassembly, or component by which it may be procured.

DESCRIPTION COLUMN

This column contains the nomenclature and/or description of the assemblies, subassemblies or components used in the end item. References are made to next higher assemblies, and to subassemblies that are further disassembled. Each assembly or subassembly is followed by its component parts, properly indented thereunder, to show their relationship to the assembly or subassembly. The attaching parts for the assembly, subassembly, or component immediately follow the part they attach in the same indentation.

UNITS-PER-ASSEMBLY COLUMN

The quantities listed in this column are the total used at the location shown and are not necessarily the total used on the end item.

COMPONENT DESIGNATOR COLUMN

This column is used to list all individual components on printed circuit boards that match the description. For example, a particular diode or capacitor may be used a number of times in different locations on the same board. To determine the specifications of a particular component, simply find it in the Component Designator column, then read the description.

FIG. NO. SUFFIX COLUMN

Complex assemblies may require multiple illustrations. These illustrations share a common figure number but are differentiated by a figure-number suffix (e. g. Fig. 2-1-a, Fig. 2-1-b, etc.). The suffixes listed in this column indicate in which illustration each item is shown.

ABBREVIATIONS

The following are abbreviations used in this parts catalog.

BRKT	BRACKET	T.H	TRUSS HEAD
SL	SLOTTED	P.H	PAN HEAD
BUT. HD.	BUTTON HEAD	S.S	SOCKET SET
SOC. CAP	SOCKET CAP	ST.STL	STAINLESS STEEL
F. H.	FLAT HEAD	M.S	MACHINE SCREW
SOC. HD	SOCKET HEAD	BRKT	BRACKET

ORDERING PARTS

All parts may be ordered from the factory. When ordering parts, always include the complete serial number of the CT 9000 ® ADV Injector, the part number required, the figure and index number, and the description of the part as indicated in the parts list. For further information contact:

Liebel-Flarsheim Company, Customer Service Department
P.O. Box 156305 2111 East Galbraith Road Cincinnati, Ohio USA 45215-6305

Service:	1-800-877-0791
Order Management:	1-800-877-0611
Fax (U.S. & Canada Orders):	1-800-998-0898
Fax (All Correspondence & International orders:	1-513-761-2388
Telex:	275370 LBFL UR

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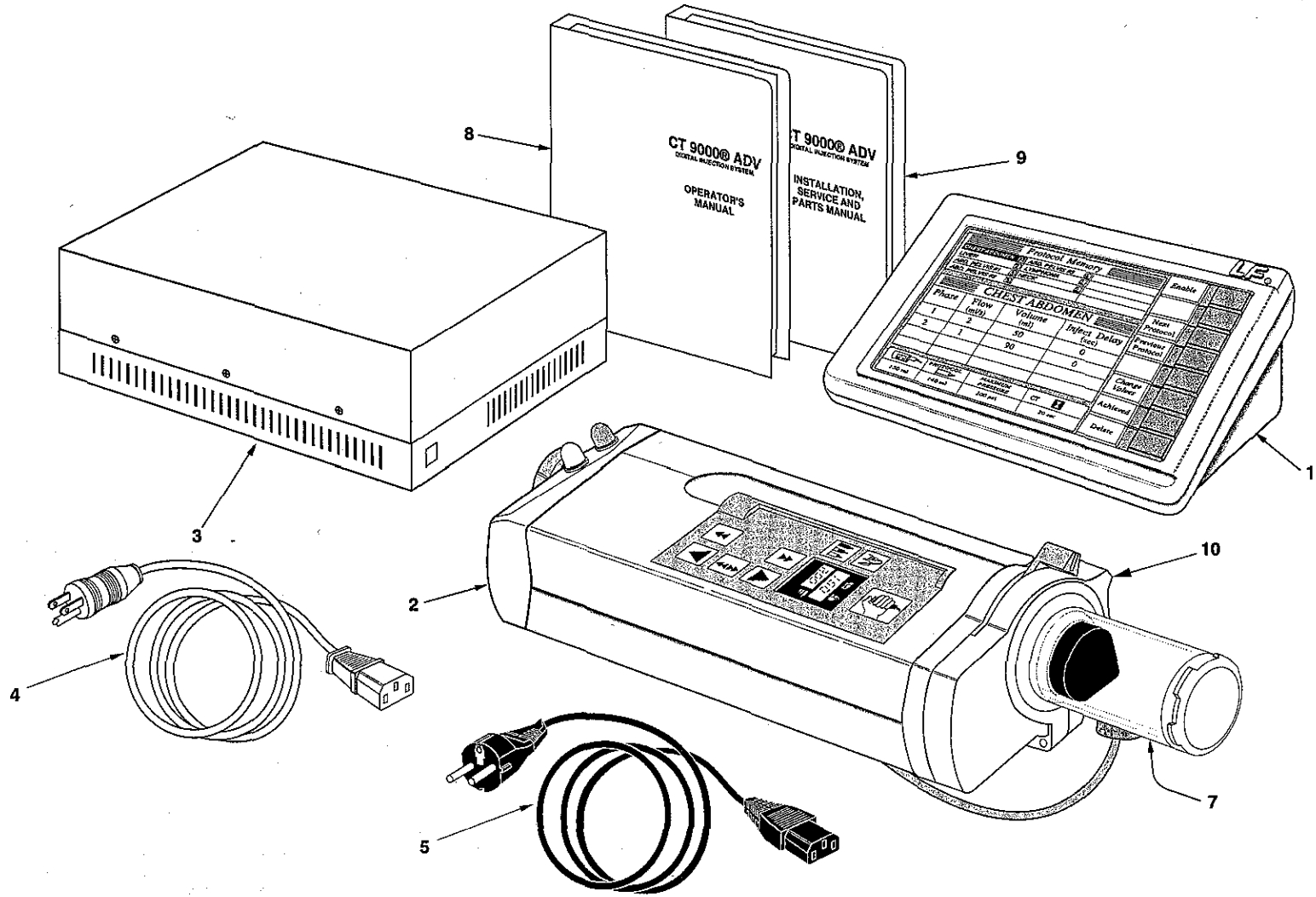
SECTION I
CT 9000 ADV SYSTEM
OPTIONS & ACCESSORIES

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
1-1	800003	International CT9000 ADV System	Ref.	
	800004	International CT9000 ADV System (EL Display)		Ref.
	800005	Domestic CT9000 ADV System	Ref.	
	800006	Domestic CT9000 ADV System (EL Display)	Ref.	
	800007	Japanese CT9000 ADV System	Ref.	
-1A	800017	Console Assembly (Used on 800003, & 800005) (See Fig. 4-1-a)		
-1B	800015	EL Console Assy. (Used on 800004 & 800006) (See Fig. 4-1-b)		
-2	800740	Power Head Assembly (See Fig. 3-1)	1	
-3	800670	Power Pack Assembly (See Fig. 2-1)	1	
-4	800120	115 VAC Power Cord (Used on all Systems)		
-5	800935	220 VAC Power Cord (Used on 800004 & 800006)		
-6	800099	Multipak 200 ml Syringe (See Fig. 1-12)	5	
-7	800114	Heater Blanket Assembly	1	
-8	800959	Operator's Manual	1	
-9	800961	Service and Parts Manual	1	
-10	800640	Pressure Jacket Assembly, 200 ml (See Fig. 1-2)	1	



800961-C Sept

Fig. 1-1 CT 9000 System (P/N 800003)

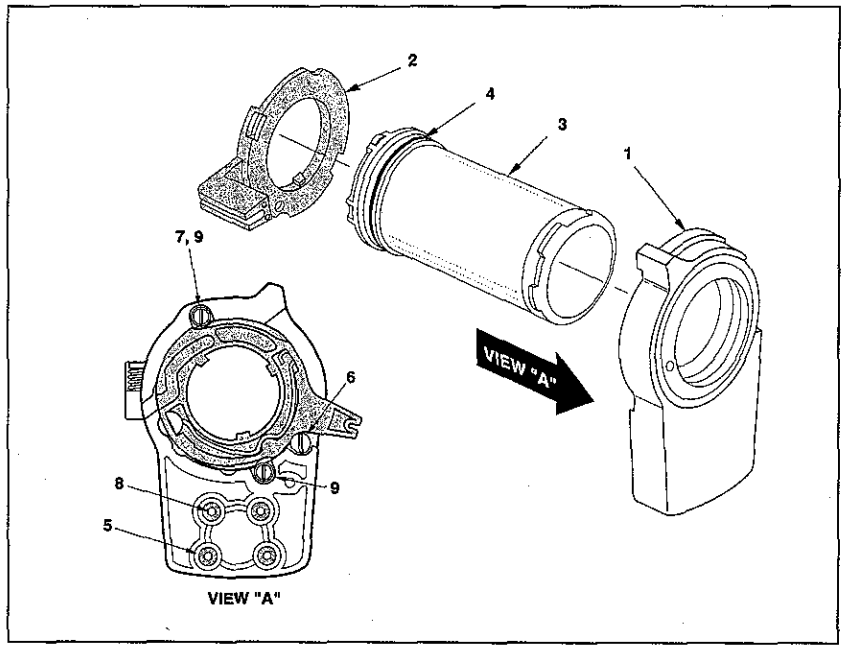


Fig. 1-2 Pressure Jacket Assembly, 200 ml (P/N 800640)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
1-2	800640	Pressure Jacket Assembly	Ref.	
-1	800639	Front Plate, Finished	1	
-2	800410	Rotating Cam Assembly (See Fig. 1-3)	1	
-3	800366	Pressure Sleeve	1	
-4	800422	"O" Ring	1	
-5	800371	Retaining Washer	4	
-6	800486	Screw, #10-32 Special	1	
-7		Screw, 10-32 x 5/16" Truss Head	4	
-8		Screw, 10-32 x 1/2" Soc. F. H.	4	
-9	800500	Washer, #10 Flat, St. Stl.	2	
-10		Grease, Stop Cock	A.R.	

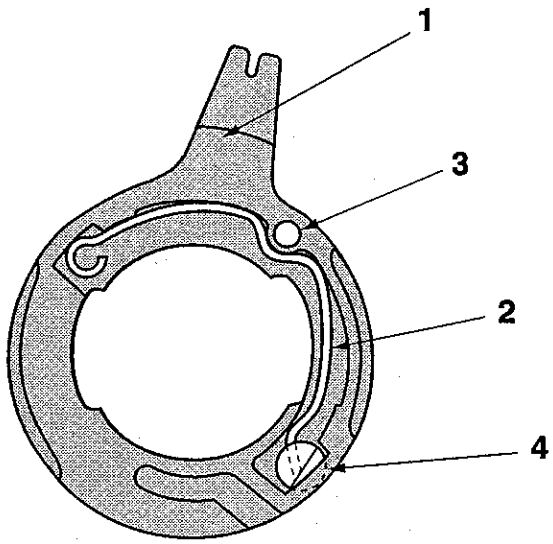


Fig. 1-3 Rotating Cam Assembly, 200 mL(P/N 800410)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
1-3	800410	Rotating Cam Assembly, 200 mL	Ref.	
-1	800361	Rotating Cam	1	
-2	800368	Spring	1	
-3	800411	Magnet, .25 O.D. x .25"	1	
-4	800417	Detent	1	

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
1-4	800677	Faceplate Assembly, Pushrod, 200 mL	Ref.	
-1	800371	Washer, Retaining	4	
-2	800411	Magnet, .25 O.D. x .25"	1	
-3	800500	Washer, Stainless Steel	2	
-4	800623	Knob, Spring Plunger	1	
-5	800763	Window, 100/200 mL	2	
-6	800721	Hinge, 100/200 mL Faceplates	2	
-7	800682	Magnet, Hall Effect	1	
-8	800712	Base, Finished 200 mL Faceplate	1	
-9	800714	Cover, Finished 200 mL Pushrod	1	
-10	800715	Rotating Cam Assembly, 100/200 ml (See Figure 1-6)	1	
-11		Screw, 10-32 x .438 Flat Socket	4	
-12		Screw, 10-32 x 5/16 S.S. Truss Hd.	2	
-13		Screw, 4-40 x 5/15 Sl. P.H. Steel	8	
-14		Screw, 4-40 x 1/4 Sl. P.H.	8	
-15		Loctite, 680 Retaining Compound	A.R.	
-16		Grease, Silicone	A.R.	
-17	800722	Standoff, Knob	1	
-18	800671	Pushrod Gripper Assy.	1	

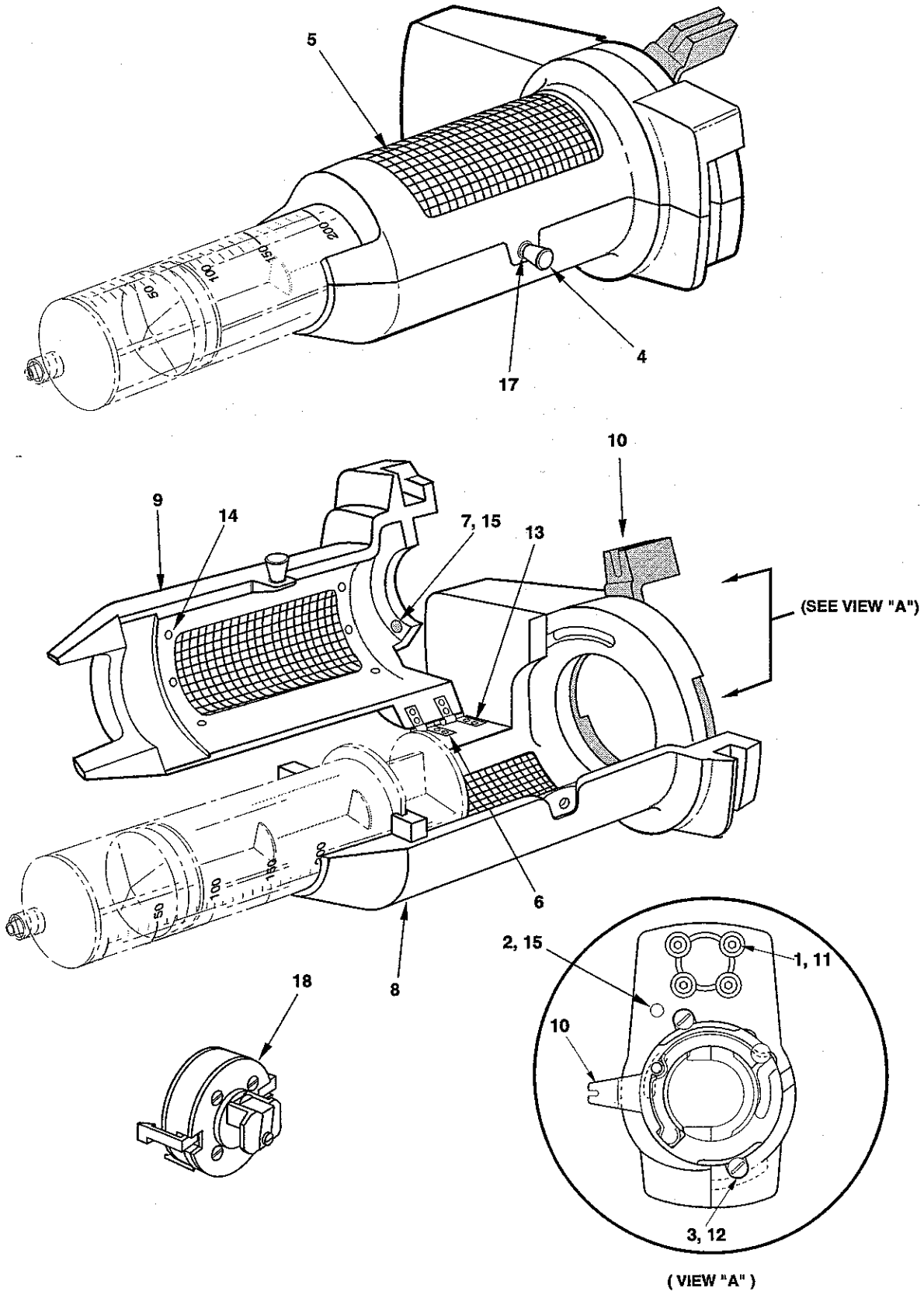


Fig. 1-4 Pushrod Faceplate Assembly, 200 ml (P/N 800677)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
1-5	800669	Faceplate Assembly, Pushrod, 100 mL	Ref.	
-1	800371	Washer, Retaining	4	
-2		Loctite® 680 Retaining Compound	A.R.	
-3	800500	Washer, Stainless Steel	2	
-4	800623	Knob, Spring Plunger	1	
-5	800763	Window, 100/200 mL	2	
-6	800721	Hinge, 100/200 mL Faceplates	2	
-7	800682	Magnet, Hall Effect	1	
-8	800711	Base, Finished 100 mL Faceplate	1	
-9	800713	Cover, Finished 100 mL Faceplate	1	
-10	800715	Rotating Cam Assembly, 100/200 mL (See Figure 1-6)	1	
-11		Screw, 10-32 x .438 Flat Socket	4	
-12		Screw, 10-32 x 5/16 S.S. Truss Hd.	2	
-13		Screw, 4-40 x 5/15 S.I. P.H. Steel	8	
-14		Screw, 4-40 x 1/4 SI. P.H.	8	
-15		Grease, Silicone	A.R.	
-16	800722	Standoff, Knob	1	
-17	800671	Pushrod Gripper Assy.	1	

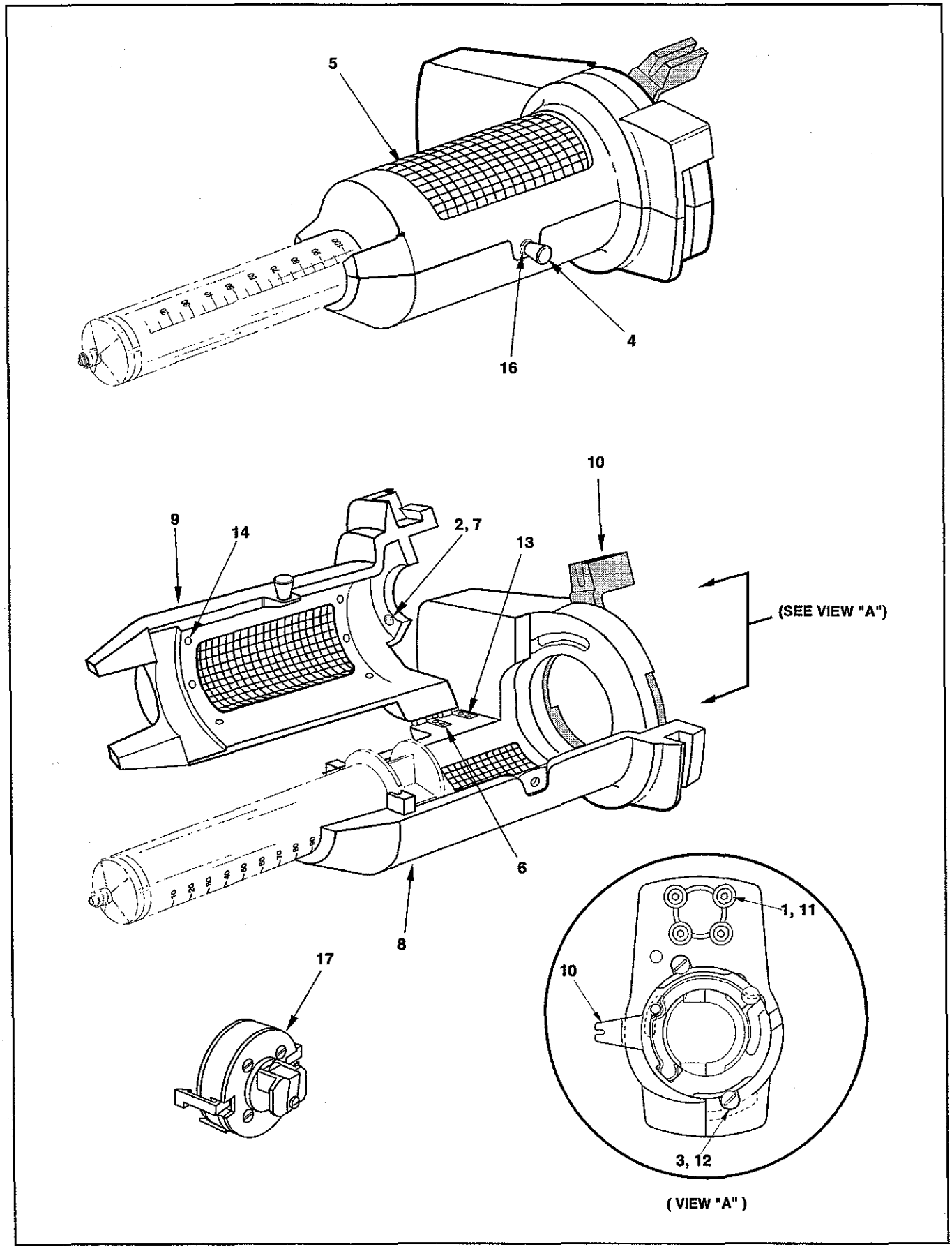


Fig. 1-5 Pushrod Faceplate Assembly, 100 mL(P/N 800669)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
1-6	800715	Rotating Cam Assembly, 100/200 mL	Ref.	
-1	800655	Rotating Cam, 100/200 mL	1	
-2	800703	Spring, Cam, 100/200 mL	1	
-3	800681	Magnetic Conductor	1	
-4	800417	Detent	1	

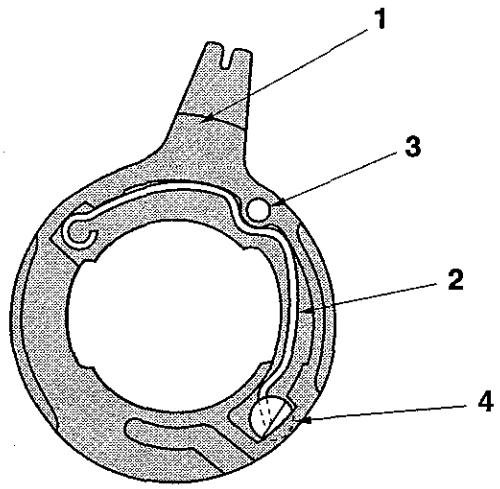


Fig. 1-6 Rotating Cam Assembly, 100/200 mL (800715)

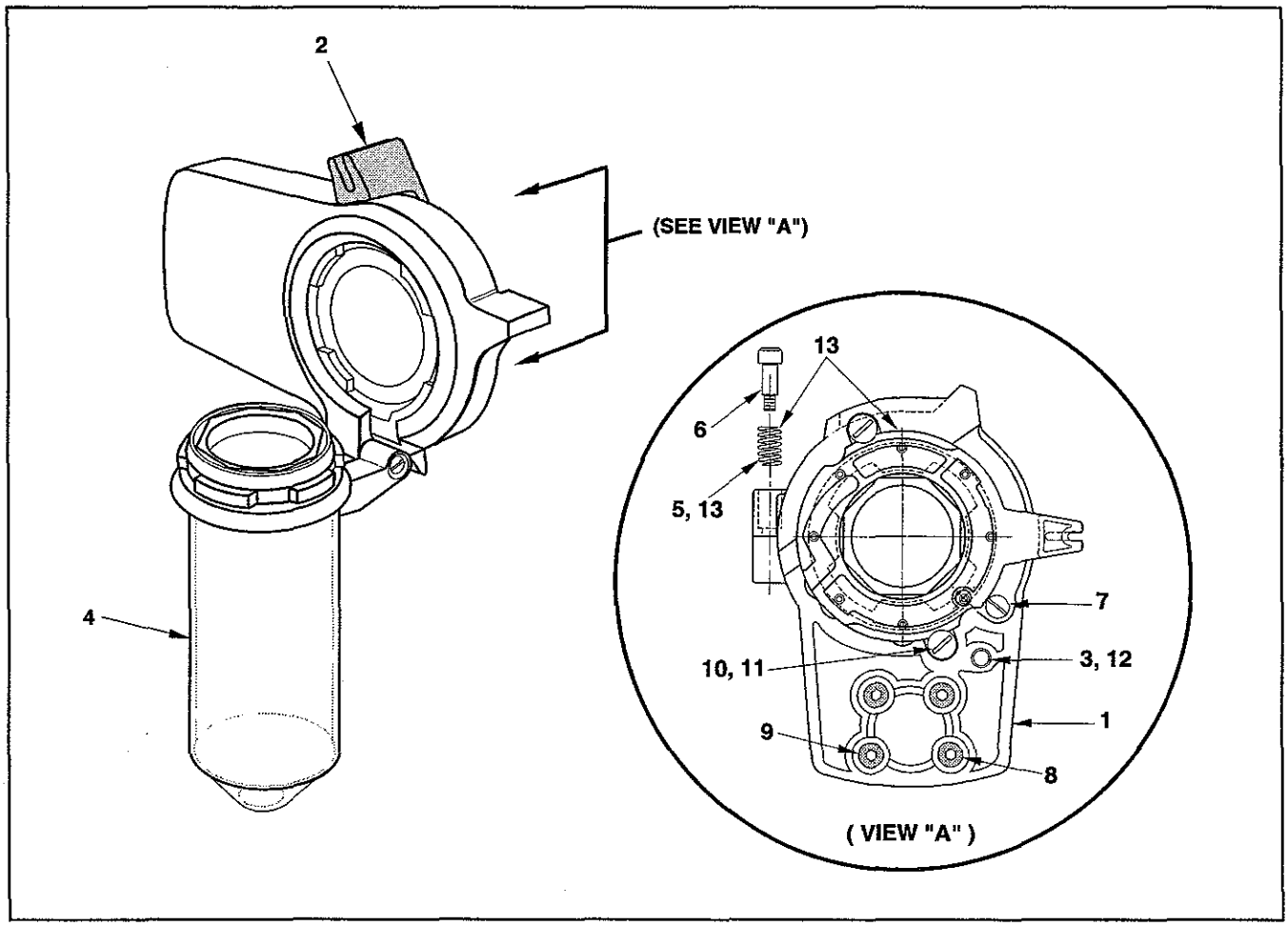


Fig. 1-7 Pressure Jacket Assembly, 125 mL (P/N 800635)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
1-7	800635	Pressure Jacket Assembly, 125 mL	Ref.	
-1	800637	Front Plate, Finished	1	
-2	800043	Rotating Cam Assembly (see Fig. 1-8)	1	
-3	800411	Magnet, .25 O.D. x .25"	1	
-4	800049	Pressure Sleeve	1	
-5	800042	Pivot Friction Spring	1	
-6	800041	Screw, Shoulder 8-32 x 5/8	1	
-7		Screw, 10-32 Binding Head	1	
-8		Screw, 10-32 Socket Flat Head	4	
-9	800371	Retaining Washer	4	
-10		Screw, 10-32 Truss Head	2	
-11	800500	Washer, #10 Stainless Steel	2	
-12		Retaining Compound	A.R.	
-13		Grease, Stop Cock	A.R.	

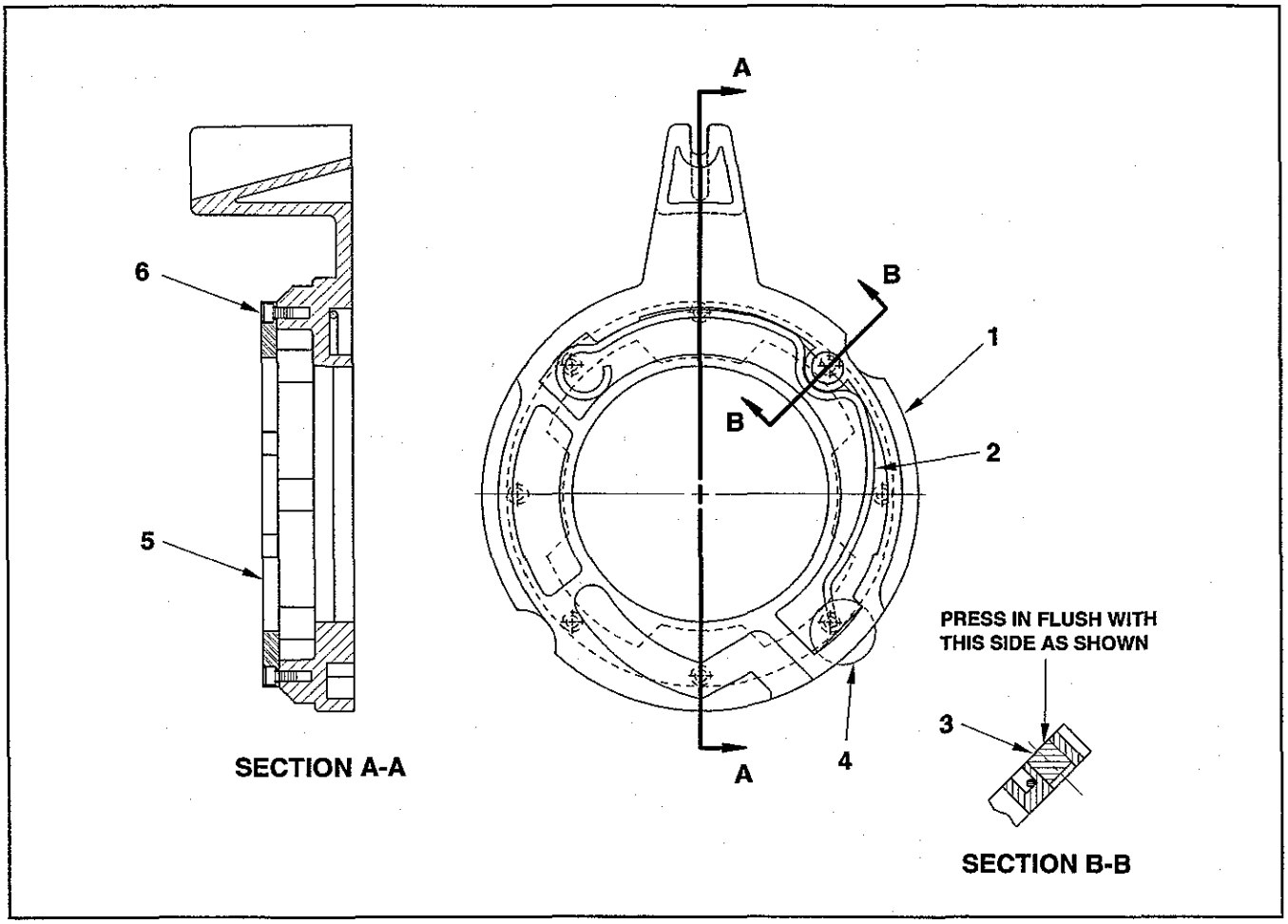


Fig. 1-8 Rotating Cam Assembly-125 mL (P/N 800043)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
1-8	800043	Rotating Cam Assembly-125 mL	Ref.	
-1	800048	Rotating Cam	1	
-2	800368	Spring	1	
-3	800411	Magnet, .25 O.D. x .25"	1	
-4	800417	Detent	1	
-5	800044	Locking Ring, 125 ML	1	
-6		Screw, #2-56 x .25 S.H.C.	8	

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
1-9	800688	Faceplate Assembly, Push & Turn, ADV	Ref.	
-1	800717	Faceplate, Painted, Push & Turn, ADV	1	
-2	800411	Magnet, .25 O.D. x .25"	2	
-3				
-4	800690	Slider, Push & Turn Faceplate	4	
-5	800691	Ring, Push & Turn Faceplate	1	
-6	800730	Spring, O-ring, Push&Turn Faceplt. 125 mL	2	
-7	800725	Detent, Push & Turn	1	
-8	800716	Seat plate, Push & Turn Faceplate	1	
-9		Screw, FLT HD, 4-40 x 5/16, stainless	4	
-10		Screw, #10-32 x 5/16, BH, SOC, SS	2	
-11	800500	Washer, stainless	2	
-12	800720	Button, Locking, Push & Turn	1	
-13	800724	Spring, Locking Button	1	
-14		Screw, shoulder, #6-32, stainless	1	
-15	257047	Loctite™-RC/609	A.R.	
-16		Screw, #10-32 x 7/16, flat sockethead	4	
-17	800371	Washer, retaining, brass	4	
-18				
-19	800719	Heater Blanket Adapter Assembly	1	
-20		Retaining Compound	A.R.	

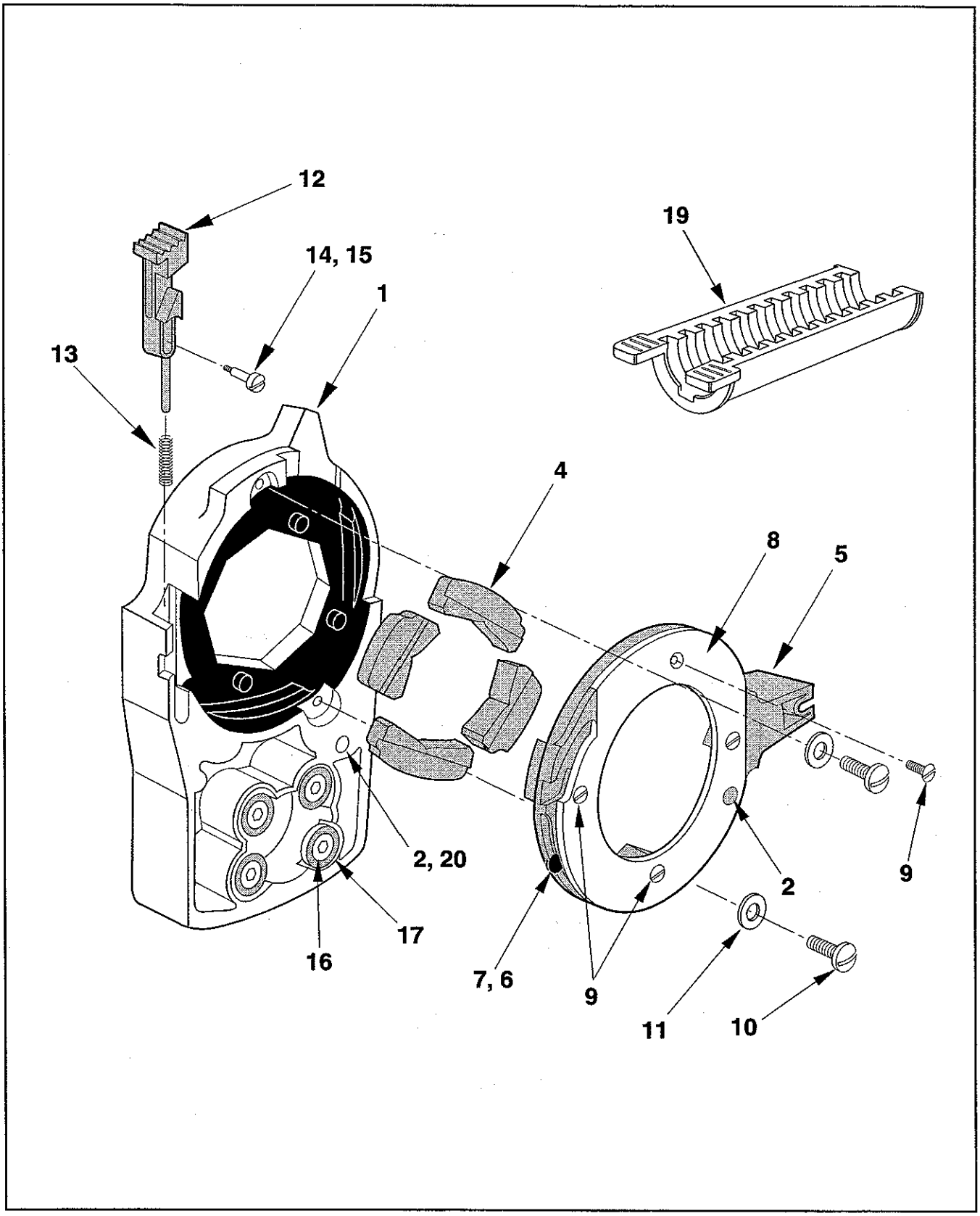


Fig. 1-9 Push & Turn Faceplate Assembly, 125mL(P/N 800688)

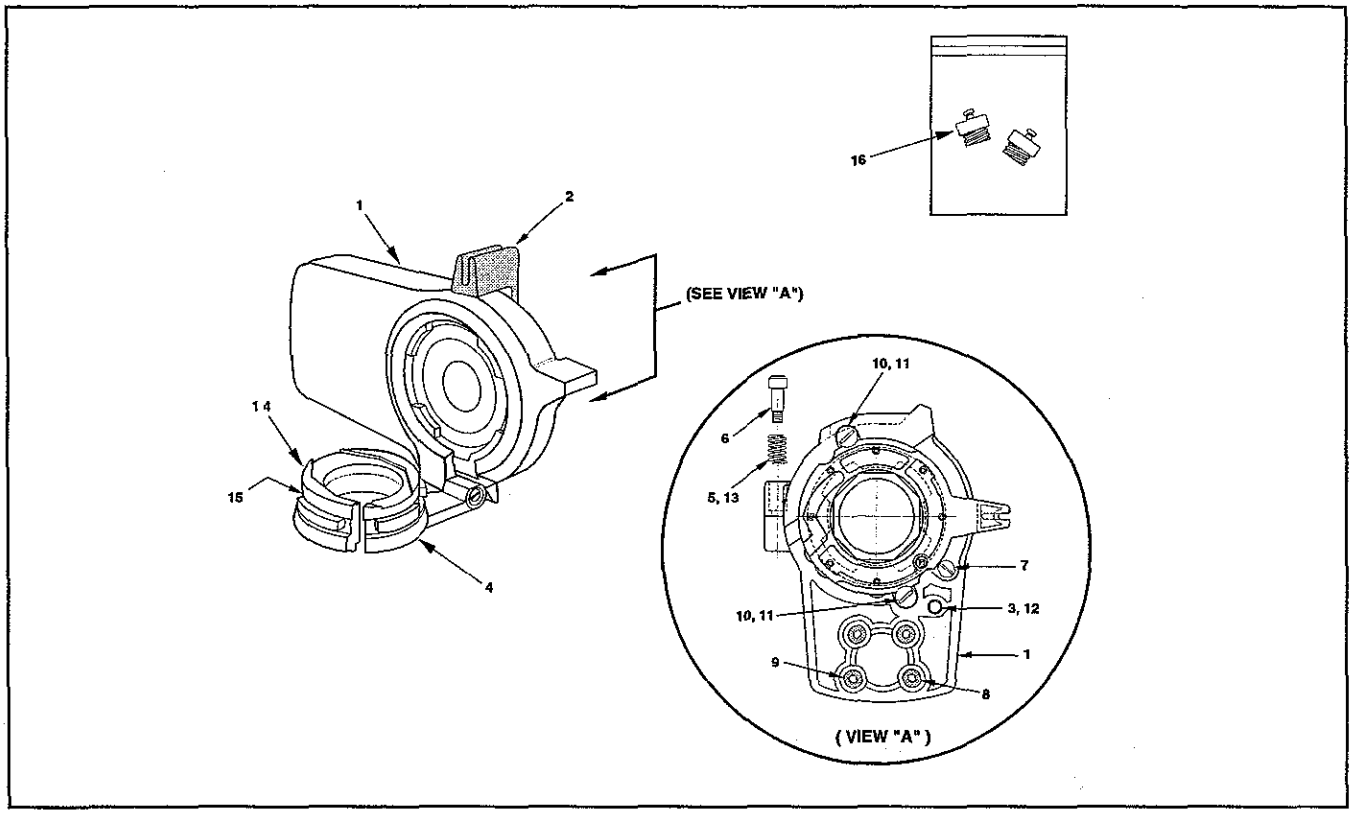


Fig. 1-10 Faceplate Assembly, 30/50 mL (P/N 800636)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
1-10	800636	Faceplate Assembly, 30/50 mL	Ref.	
-1	800637	Faceplate, Finished	1	
-2	800638	Rotating Cam Assembly (see Fig. 1-11)	1	
-3	800411	Magnet, Hall Effect	1	
-4	800595	Pressure Sleeve, 30/50 mL	1	
-5	800042	Pivot Friction Spring	1	
-6		Screw, Shoulder 8-32 x 5/8	1	
-7		Screw, 10-32 Binding Head	1	
-8		Screw, 10-32 Socket Flat Head	4	
-9	800371	Retaining Washer	4	
-10		Screw, 10-32 Truss Head	2	
-11	800500	Washer, #10 Stainless Steel	2	
-12		Retaining Compound	A.R.	
-13		Grease, Stop Cock	A.R.	
-14	800610	Insert,m Syringe, 30/50 mL	1	
-15		Adhesive, Cyanoacrylate	A.R.	
-16	800675	Button, 30/50 mL Syringe	5	

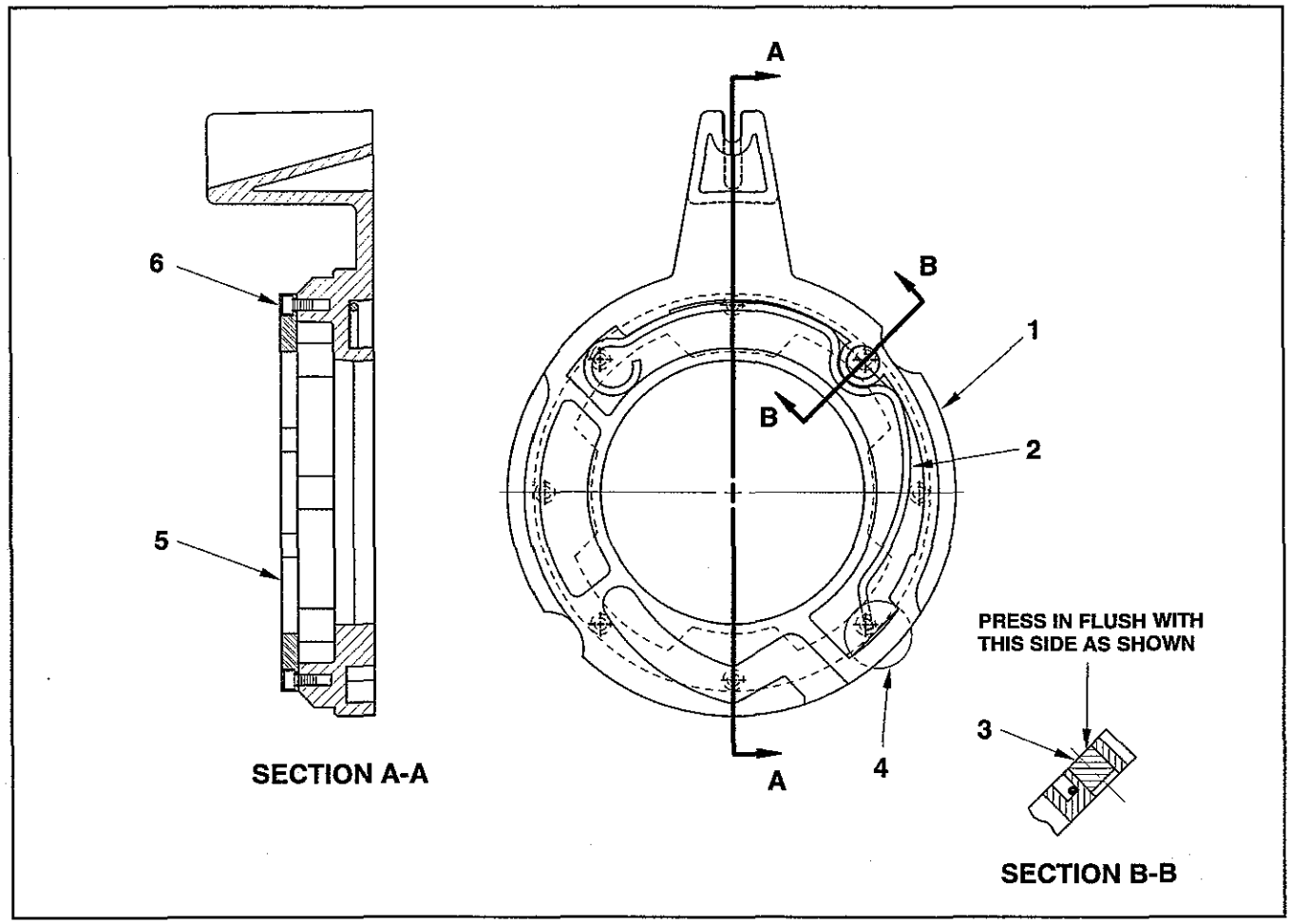


Fig. 1-11 Rotating Cam Assembly-30/50 mL (P/N 800638)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
1-11	800638	Rotating Cam Assembly-30/50 mL	Ref.	
-1	800608	Rotating Cam, 30/50 mL	1	
-2	800368	Spring	1	
-3	800411	Magnet, .25 O.D. x .25"	1	
-4	800417	Detent	1	
-5	800044	Locking Ring, 125 ML	1	
-6		Screw, #2-56 x .25 S.H.C.	8	

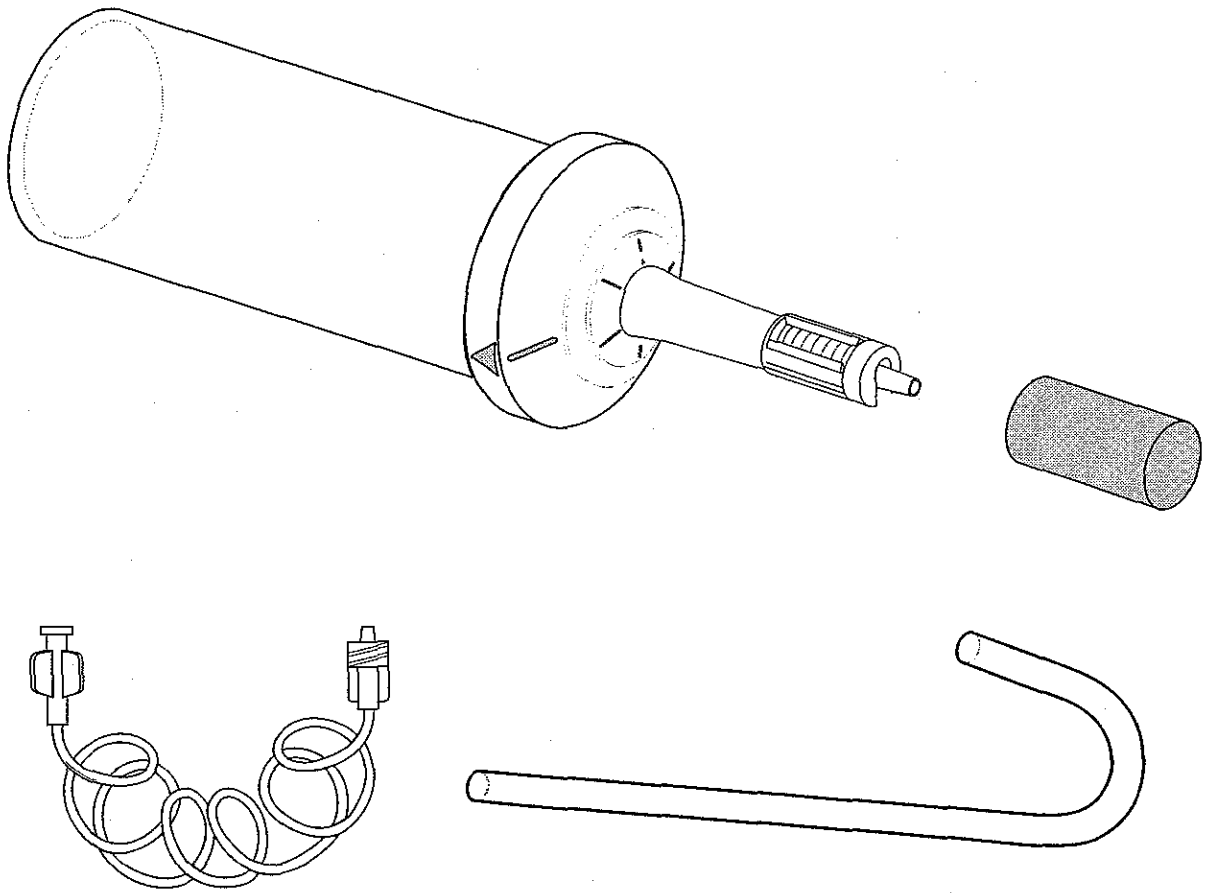


Fig. 1-12 Syringe Multipak, 200 mL (P/N 800099)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
1-12	800099	Syringe Multipak, 200 mL	Ref.	
	Includes:	200 mL Syringe Assembly Coiled Tubing Disposable Filler Tube Protective Cap		

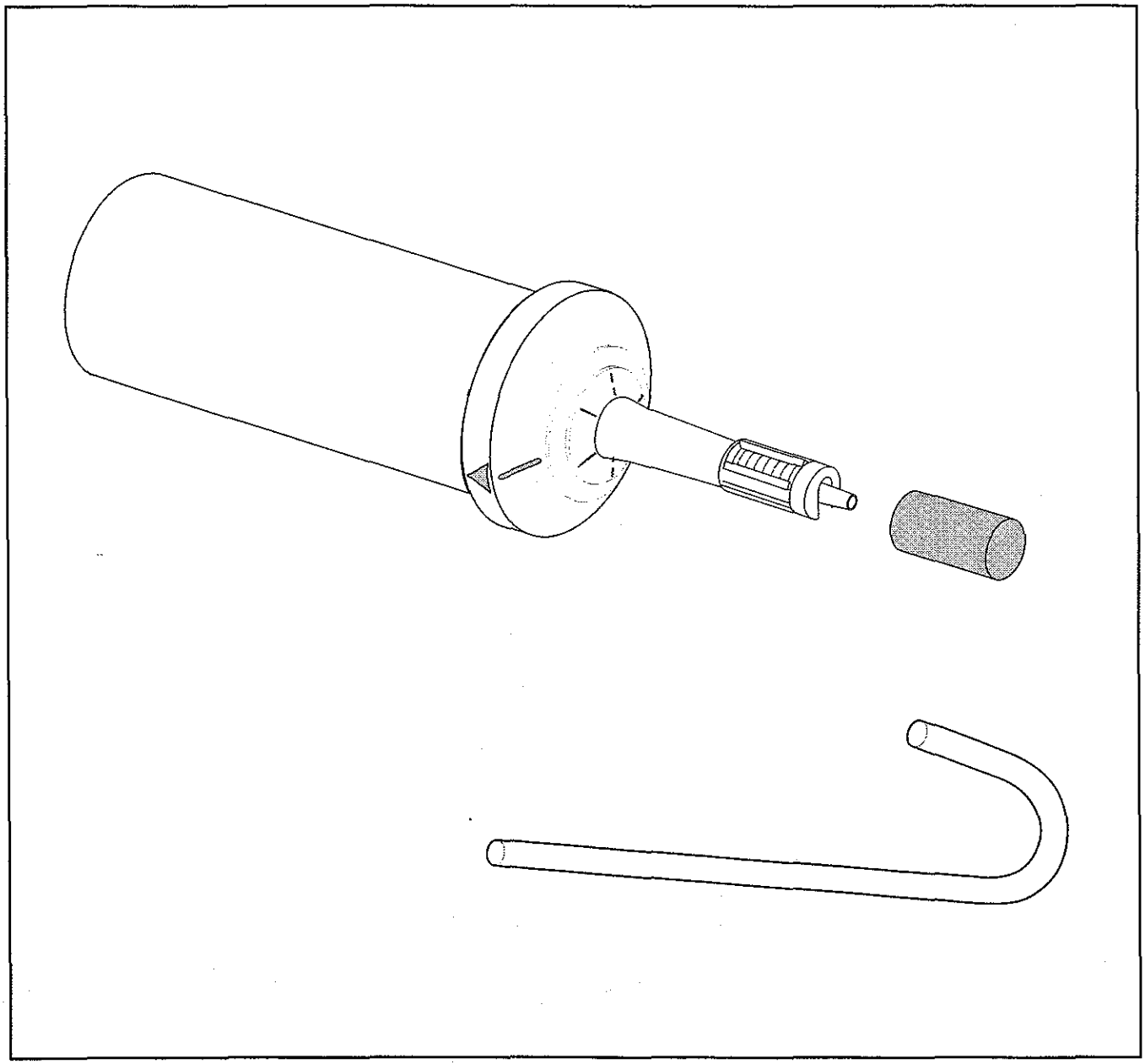


Fig. 1-13 Syringe with Handifil, 200 mL (P/N 800096)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
1-13	800096	Syringe with Handifil, 200 mL	Ref.	
	Includes:	200 mL Syringe Assembly Disposable Filler Tube Protective Cap		

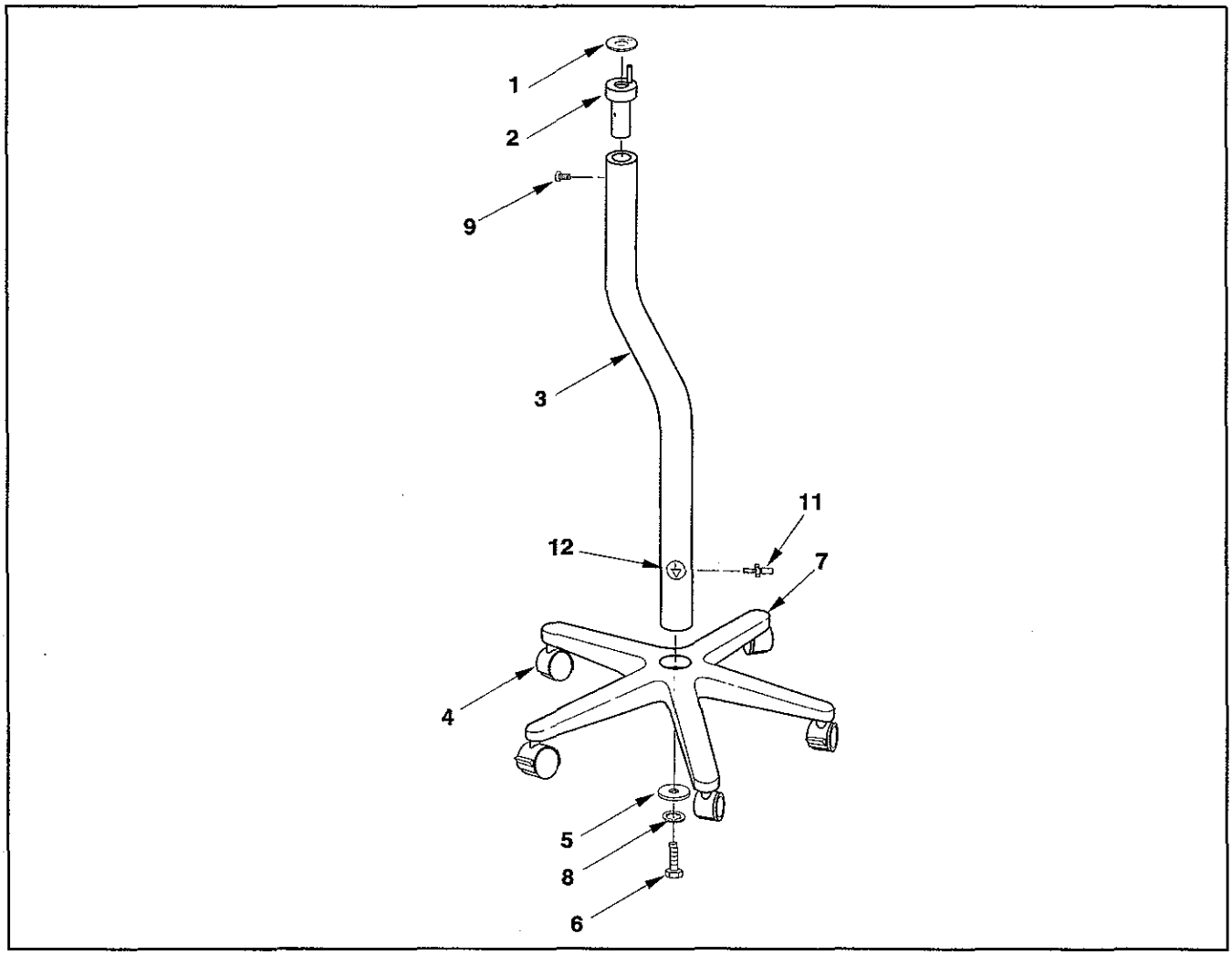


Fig. 1-14 Remote Stand Assembly (P/N 800112)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
1-14	800112	Remote Stand Assembly	Ref.	
-1	800535	Washer, Neoprene	1	
-2	800533	Pivot Attachment Assembly	1	
-3	800527	Vertical Column	1	
-4	800528	Caster, Non-Locking	5	
-5	800531	Washer	1	
-6		Screw, M12 x 60 Hex Hd. Cap	1	
-7	800536	Roller Base	1	
-8		Washer, M12 Internal Tooth	1	
-9		Screw, M5 x 10 FLT. Hd. Soc. Cap	1	
-10				
-11	800507	Plug - Equipotential	1	
-12		Label - Equipotential	1	
-13		Tie Rap - Large	4	

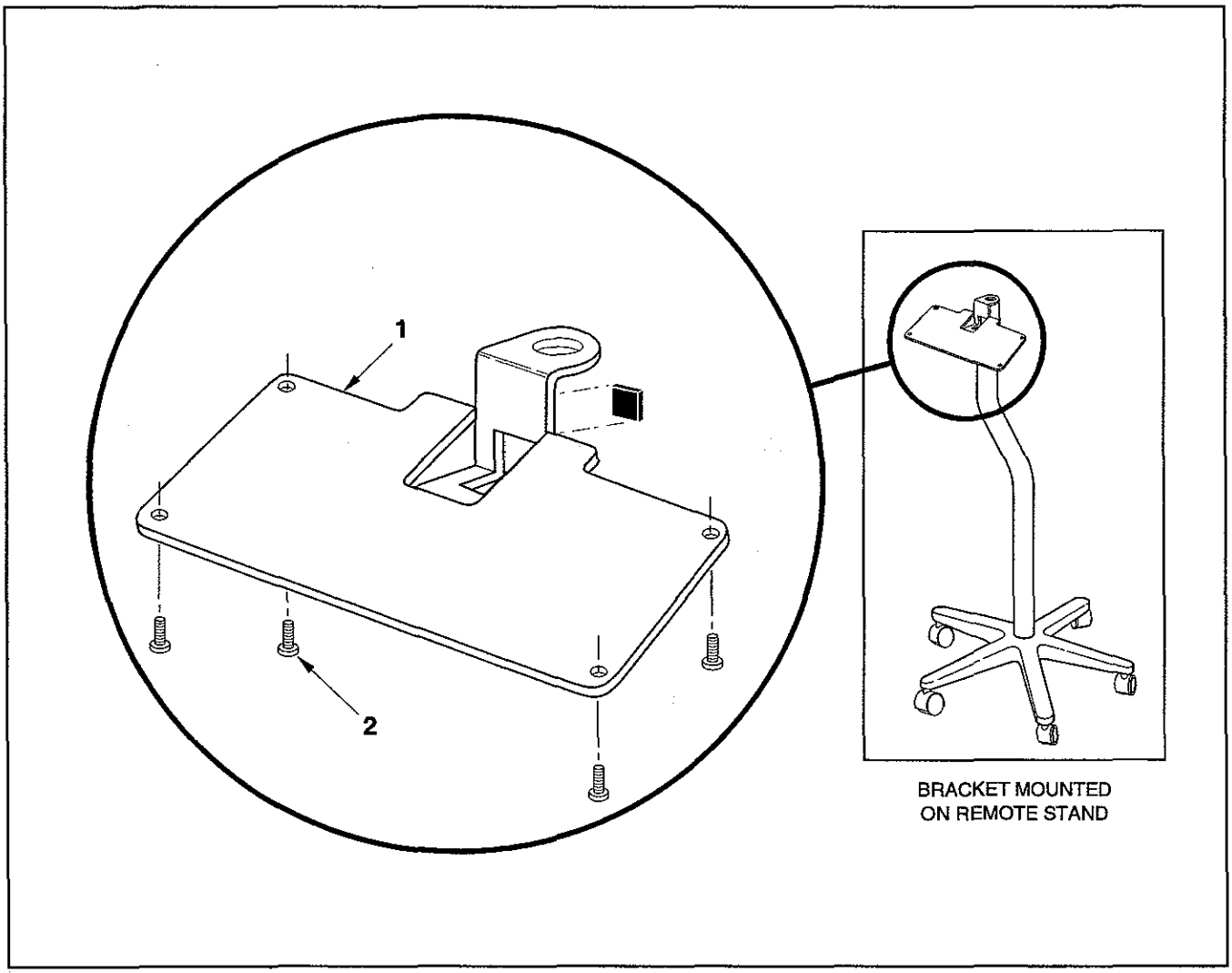


Fig. 1-15 Bracket, Console Remote Stand (P/N 800444)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
1-15	800444	Bracket, Console Remote Stand	Ref.	
-1		Bracket Assembly, Remote Stand	1	
-2		Screws, 8-32 x 1/4	4	

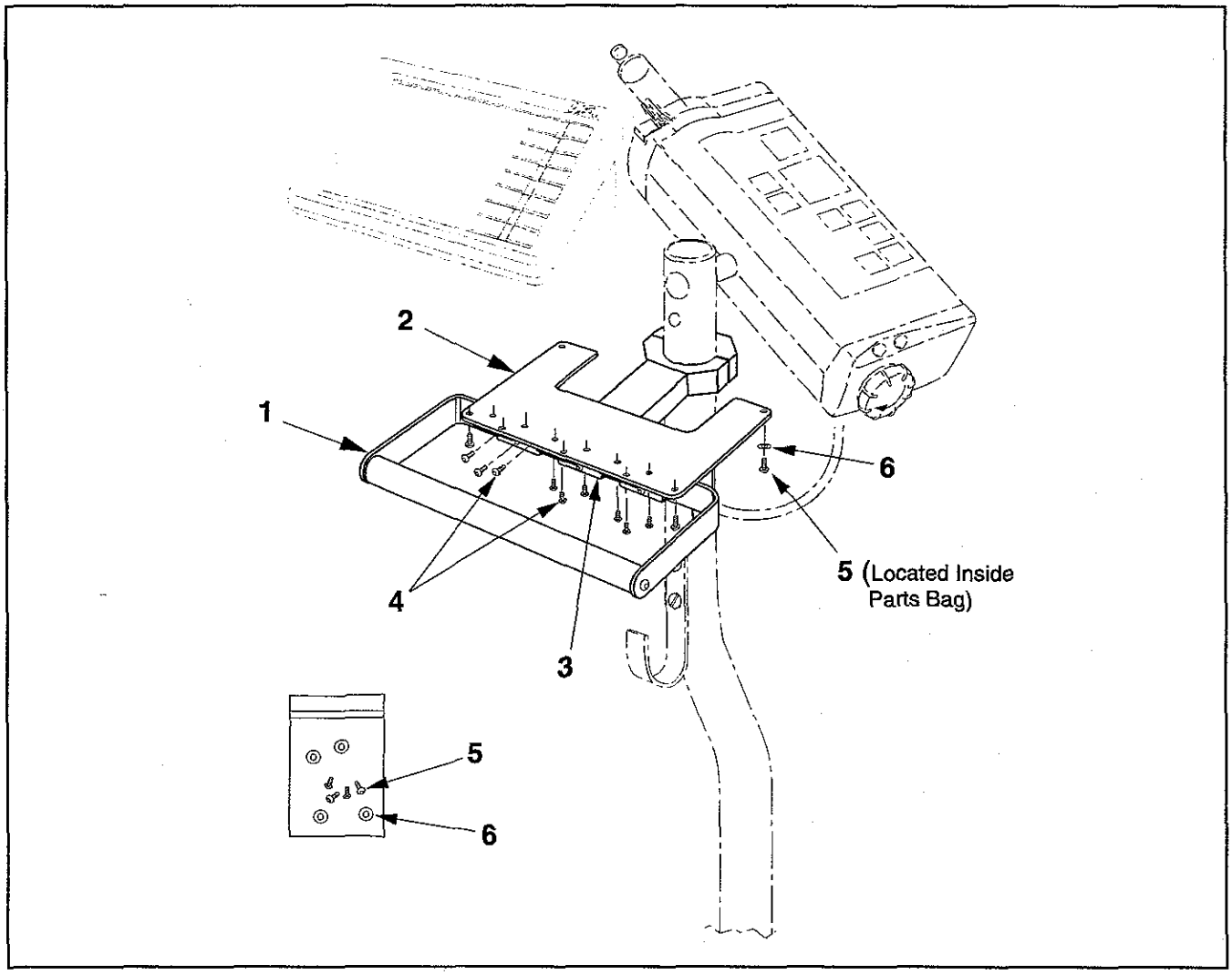


Fig. 1-16 Bracket, Console Remote Stand (P/N 800683)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
1-16	800683	Console Mount	Ref.	
-1	800684	Bracket, Console Mount	1	
-2	800685	Plate, Console Mount	1	
-3	902058	Hinge, Constant Torque	3	
-4	800699	Screw, #8-32 x 5/16", Gloss Black	18	
-5		Screw, #6-32 x 12", Phil. Recessed	4	
-6		#6 Lock Washer	4	

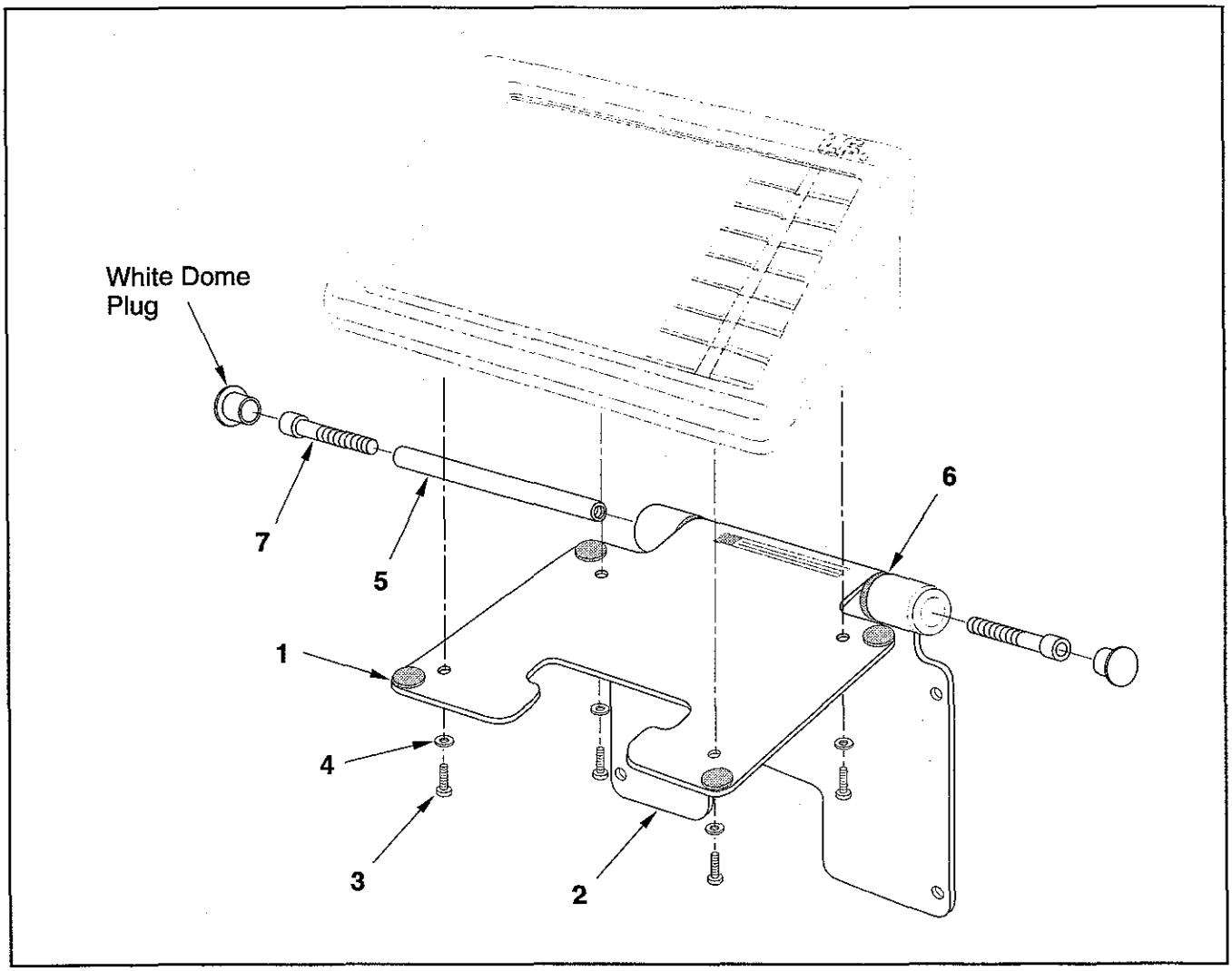


Fig. 1-17 Bracket, Console Pivoting (P/N 800445)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
1-17	800445	Bracket, Console Pivoting	Ref.	
-1		Bottom Hinge Plate Assembly	1	
-2		Top Hinge Plate Assembly	1	
-3		Screw, 6-32 x 5/16 Lg. P.H.	4	
-4		Washer, #6-Ext. Tooth	4	
-5		Pin	1	
-6		Friction Washer	2	
-7		Screw, 3/8-16 x 1-3/4 S.H. Stl. Cap	2	
-8		Instruction Sheet	1	

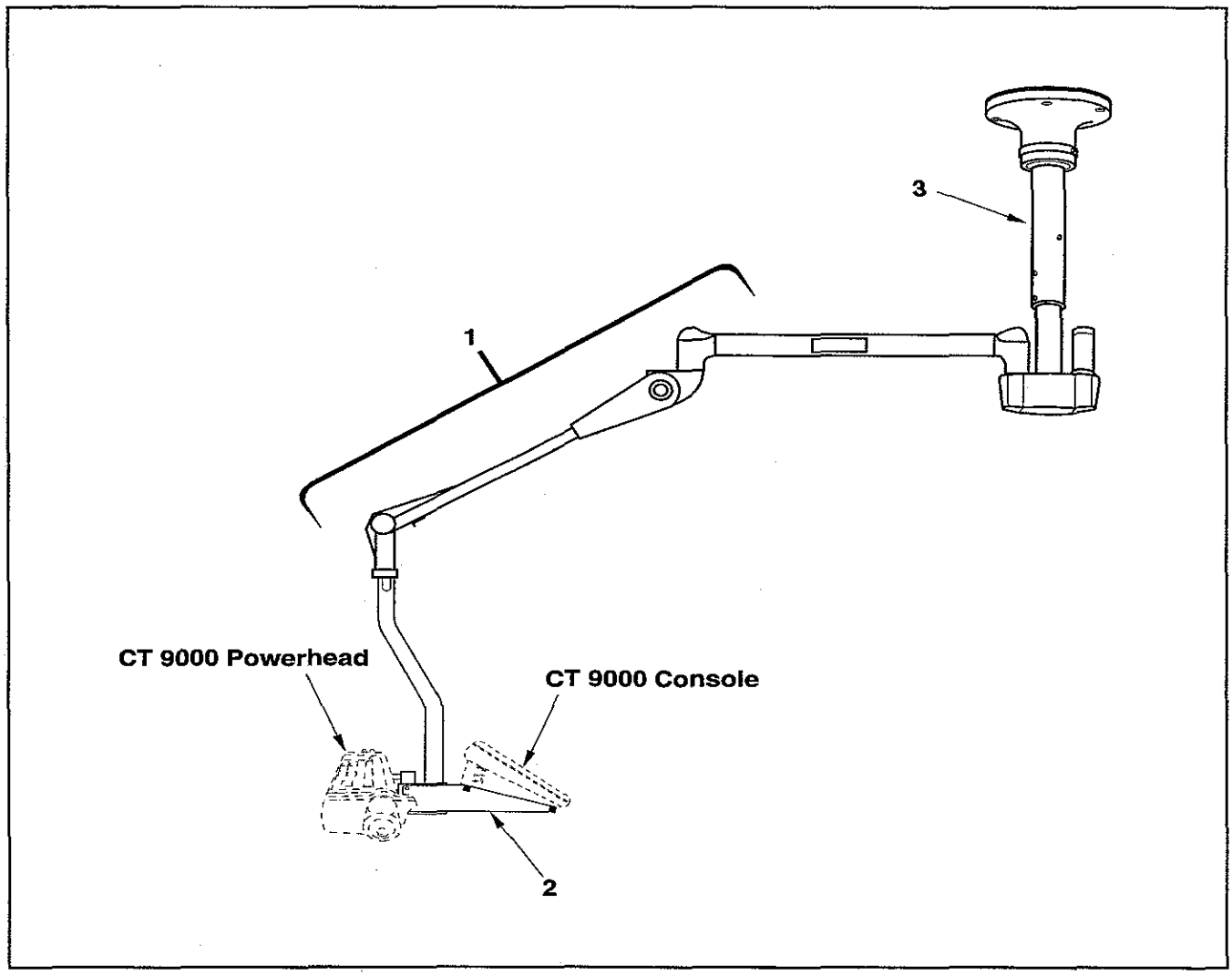


Fig. 1-18 Ceiling Mount System

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
1-18				
-1	241047	Arm & Bracket Assembly	1	
-2	241048	Console Bracket	1	
-3	241045	Short Column (19")	1	
	241046	Long Column (30")	1	

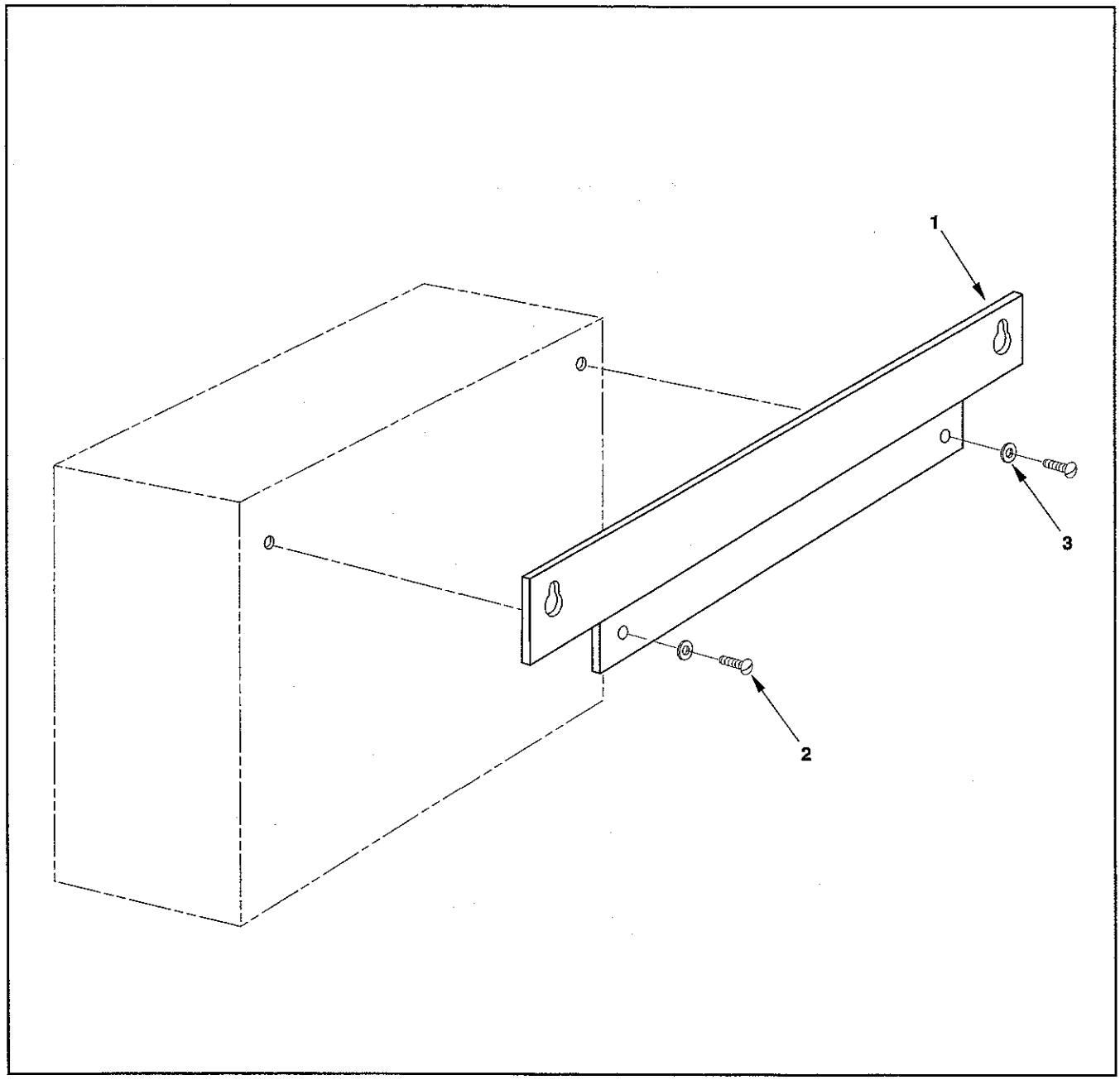


Fig. 1-19 Wall Mount Kit (P/N 800060)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
1-19	800060	Wall Mount Kit	Ref.	
-1	800492	Bracket, Wall Mount	1	
-2		Screw, 1/4"-20 Slotted Truss Hd.	2	
-3		Washer, #1/4" Internal Tooth	2	

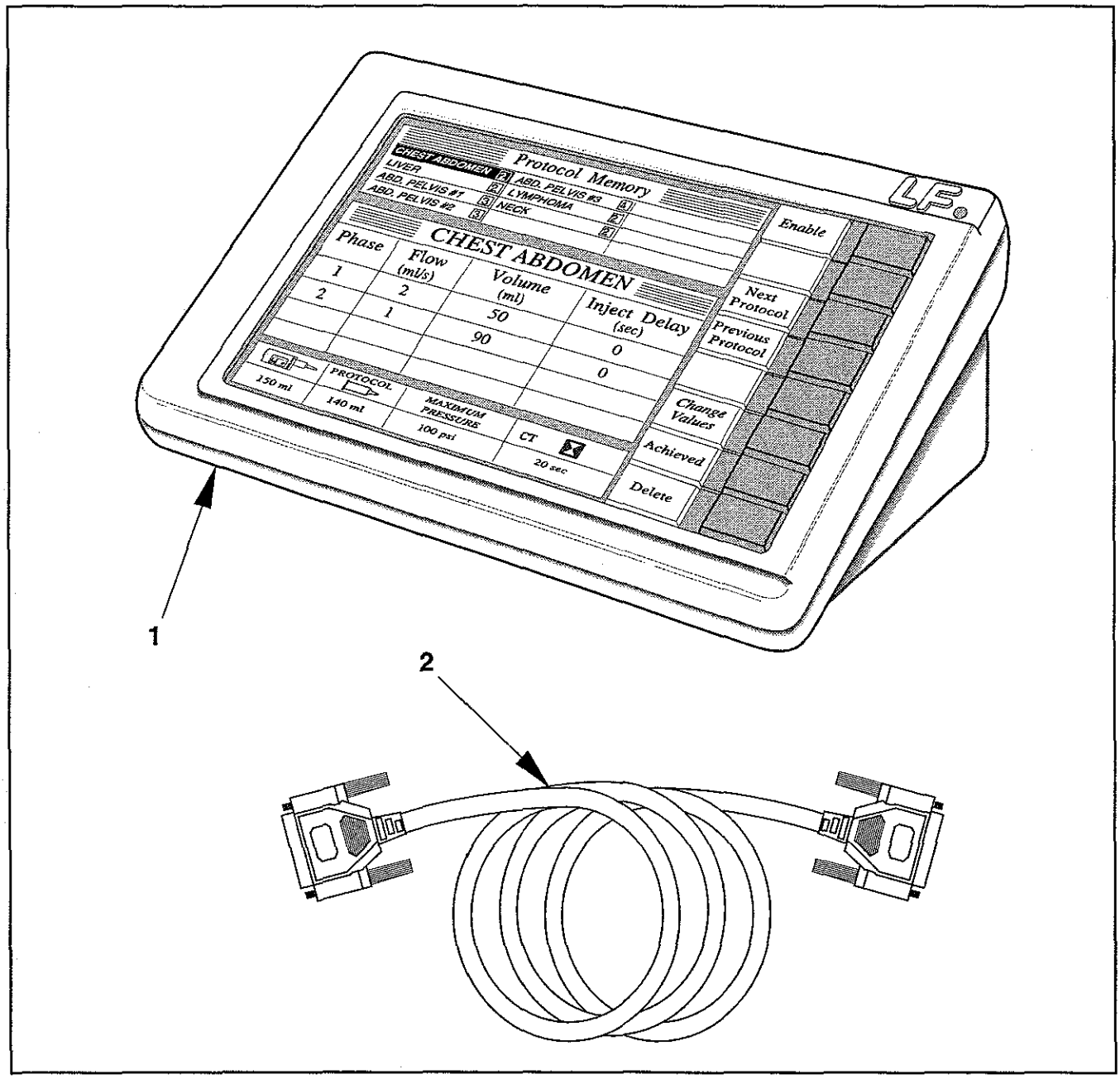


Fig.1-20 Auxiliary Console Kit (P/N 800012)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
1-20	800012	Auxiliary Console Kit	Ref.	
-1	800017	Console Assembly	1	
-2	800105	Cable Assembly, 15 Pin Male/Female D Shell 50'	1	

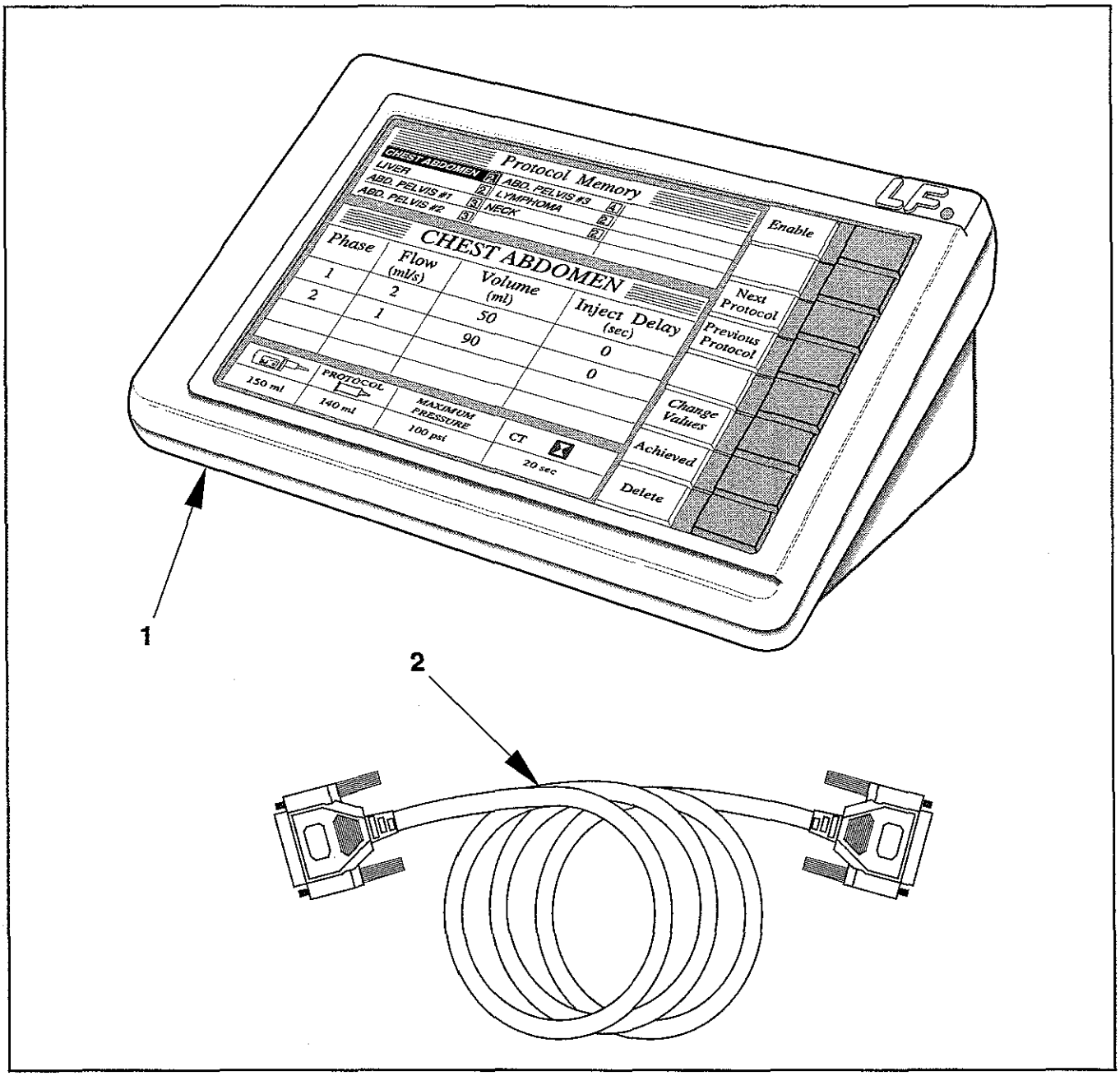


Fig.1-20a Auxiliary Console Kit (EL) (P/N 800016)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
1-20a	800016	Auxiliary Console Kit	Ref.	
-1	800015	Console Assembly	1	
-2	800105	Cable Assembly, 15 Pin Male/Female D Shell 50'	1	

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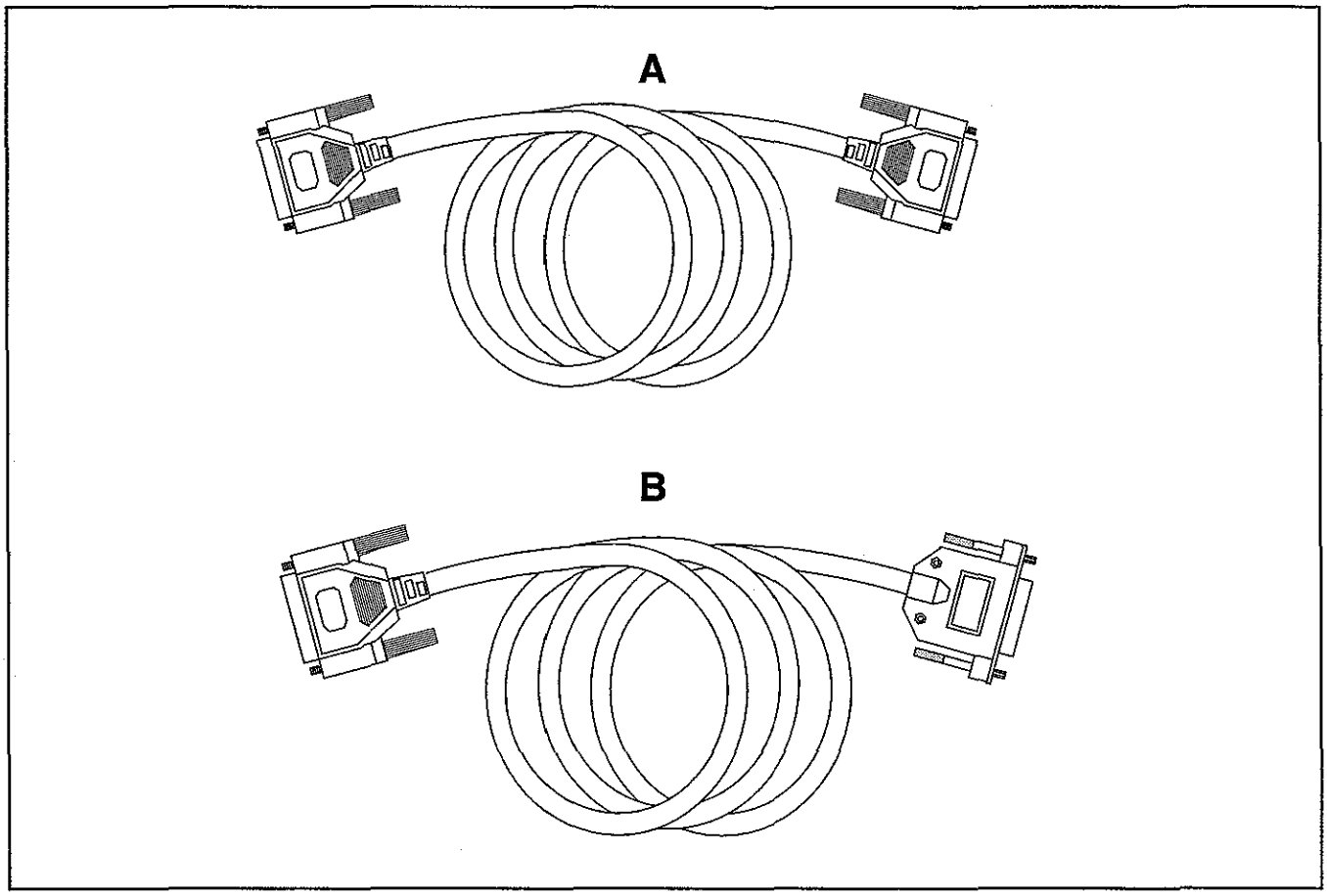

Fig. 1-21 Console Extension Cables

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
1-21	Ref	Console Extension Cables	Ref.	
-1	800598	Cable Assembly, 15 Pin, Male/Female D Shell 6'	1	A
	800137	Cable Assembly, 15 Pin, Male/Female D Shell 25'	1	A
	800105	Cable Assembly, 15 Pin, Male/Female D Shell 50'	1	A
	800106	Cable Assembly, 15 Pin, Male/Female D Shell 75'	1	A
	800107	Cable Assembly, 15 Pin, Male/Female D Shell 100'	1	A
-2	800122	Cable Assembly, 15 Pin, Male/Female D Shell 50', 1 Side Molded	1	B
	800123	Cable Assembly, 15 Pin, Male/Female D Shell 75', 1 Side Molded	1	B
	800124	Cable Assembly, 15 Pin, Male/Female D Shell 100', 1 Side Molded	1	B

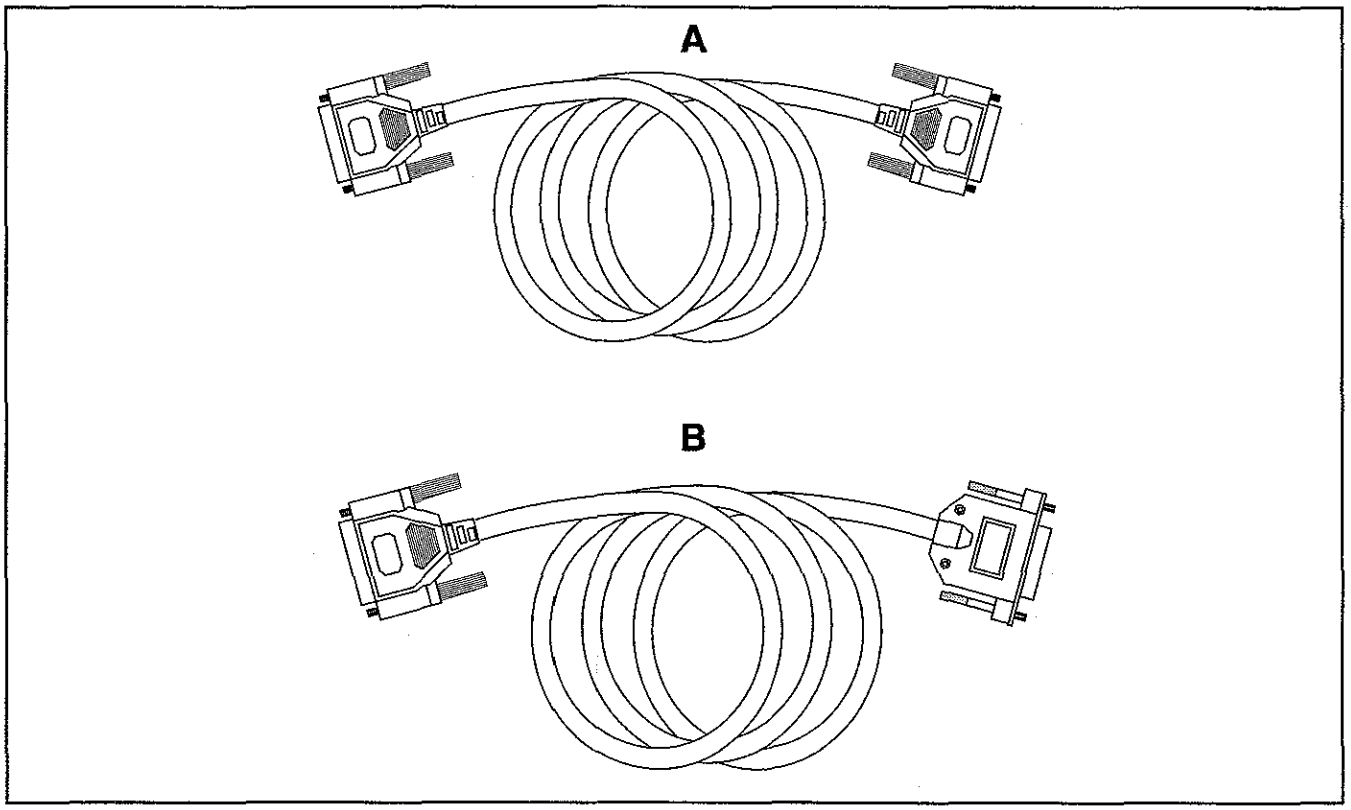

Fig. 1-22 Powerhead Extension Cables

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
1-22	Ref	Powerhead Extension Cables	Ref.	
-1	800136	Cable Assembly, 25 Pin Male/Female D Shell 25'	1	A
	800125	Cable Assembly, 25 Pin Male/Female D Shell 50'	1	A
	800126	Cable Assembly, 25 Pin Male/Female D Shell 75'	1	A
	800127	Cable Assembly, 25 Pin Male/Female D Shell 100'	1	A
-2	800599	Cable Assembly, 25 Pin Male/Female D Shell 6', 1 Side Molded	1	B
	800109	Cable Assembly, 25 Pin Male/Female D Shell 50', 1 Side Molded	1	B
	800110	Cable Assembly, 25 Pin Male/Female D Shell 75', 1 Side Molded	1	B
	800111	Cable Assembly, 25 Pin Male/Female D Shell 100', 1 Side Molded	1	B

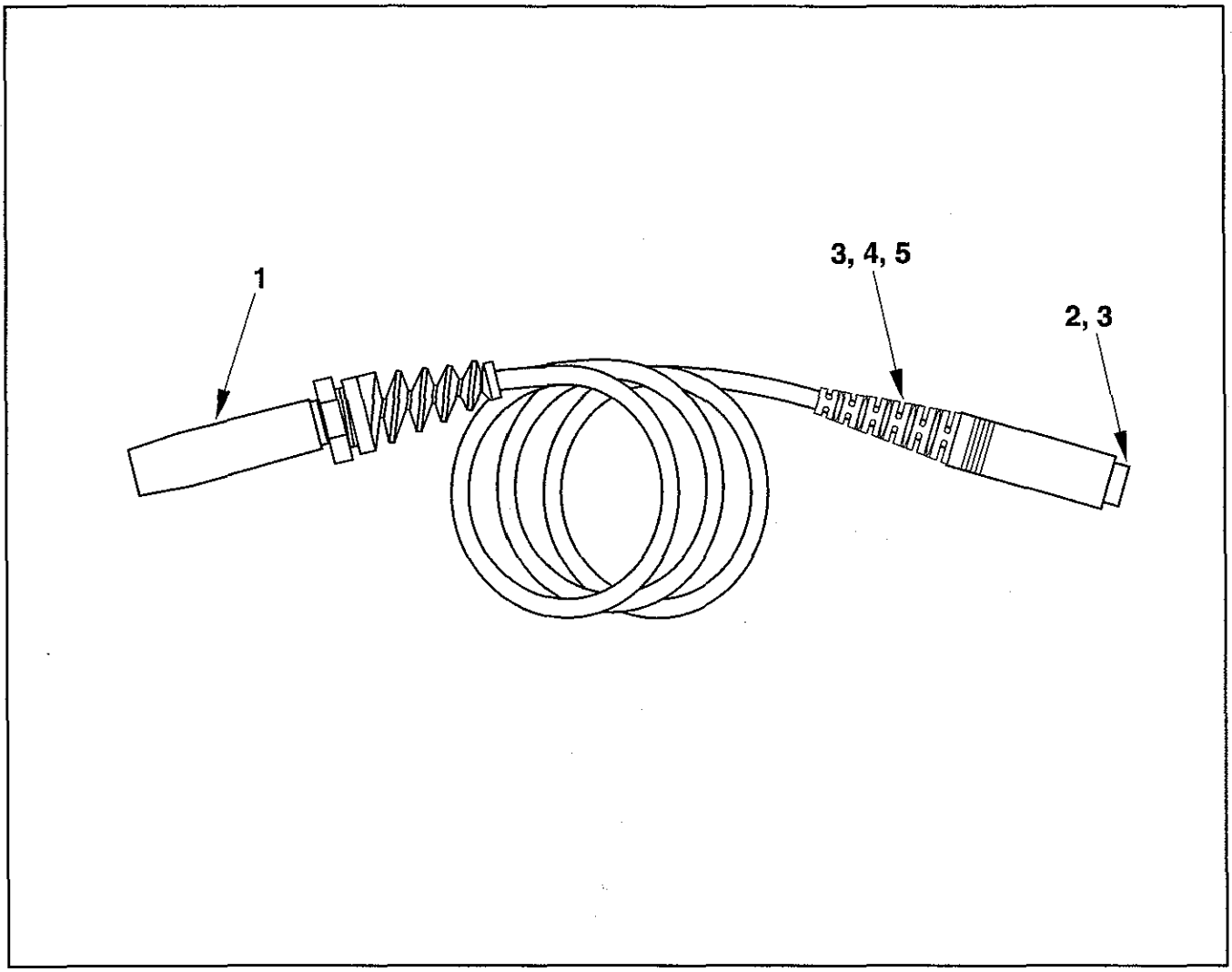

Fig. 1-23 Cable Assembly, 40 FT. Start Switch (P/N 800919)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
1-23	800919	Cable Assembly, 40 FT. Startswitch	Ref.	
-1		Handswitch and cable Assembly	1	
-2		Contact Pin Circular Din	4	
-3		Connector, 8 Position Housing	1	
-4		Cord Guard, Circular Din	1	
-5		Ferrule, Circular Din Conn.	1	

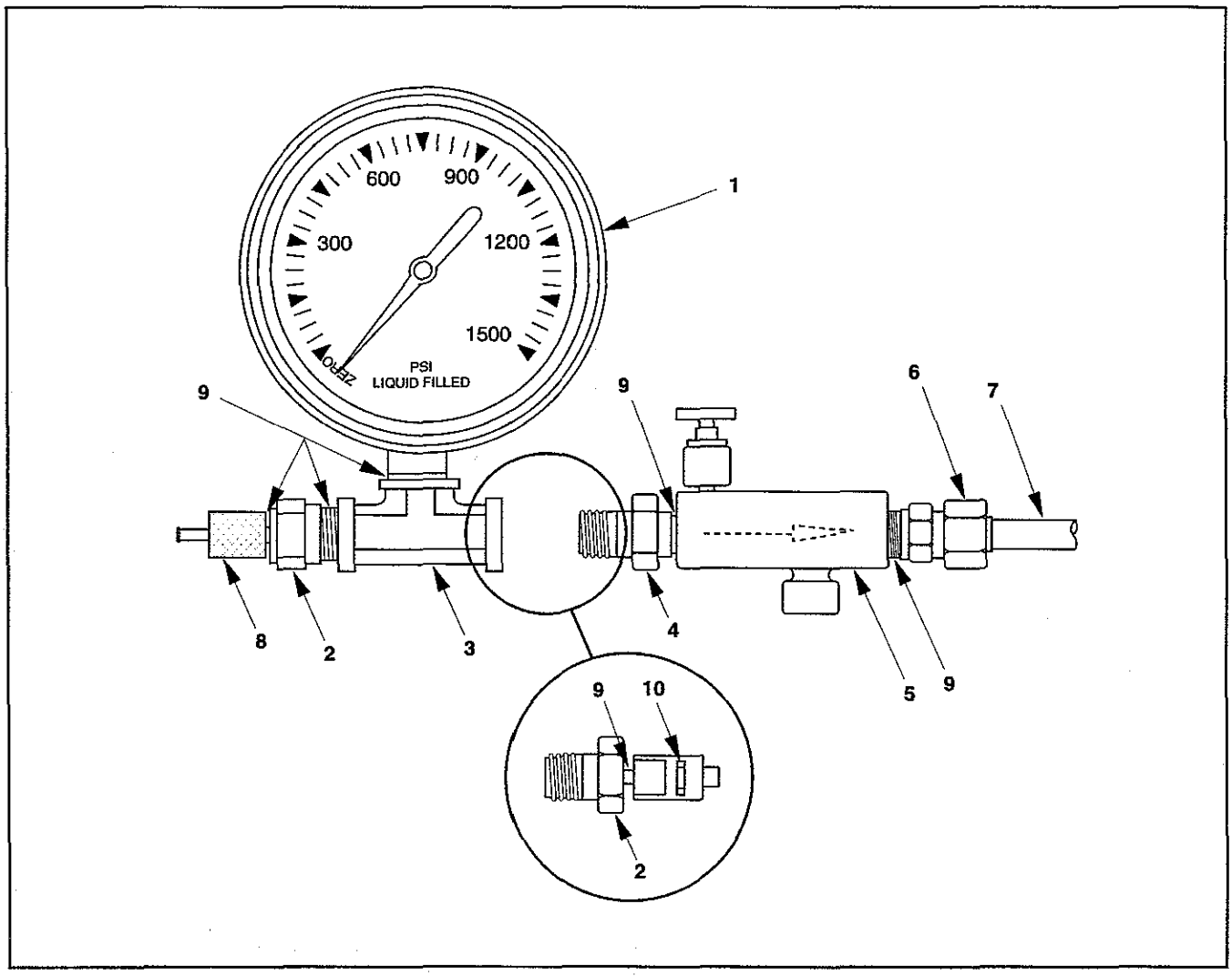

Fig. 1-24 Pressure Test Fixture Kit (P/N 600867)

Fig. & Index Number	Part Number	Description	Units Per Ass'y.	Component Designator
1-24	600867	Pressure Test Fixture Kit	Ref.	
-1	600572	Gauge, 1500 PSI Max. Liq. Fill	1	
-2		Adapter	2	
-3		Pipe Tee, Female	1	
-4		Pipe Nipple, Male 1/4 x 1/8	1	
-5	500311	Valve, Flow Control	1	
-6		Connector, 1/8 Male Compression	1	
-7		Tubing, Nylon 1/4 O.D.	Ref.	
-8		Luer, Female 10-32	1	
-9		Hyraulic Sealant	A.R.	
-10		Luer Needle Lock, Male 10-32	1	

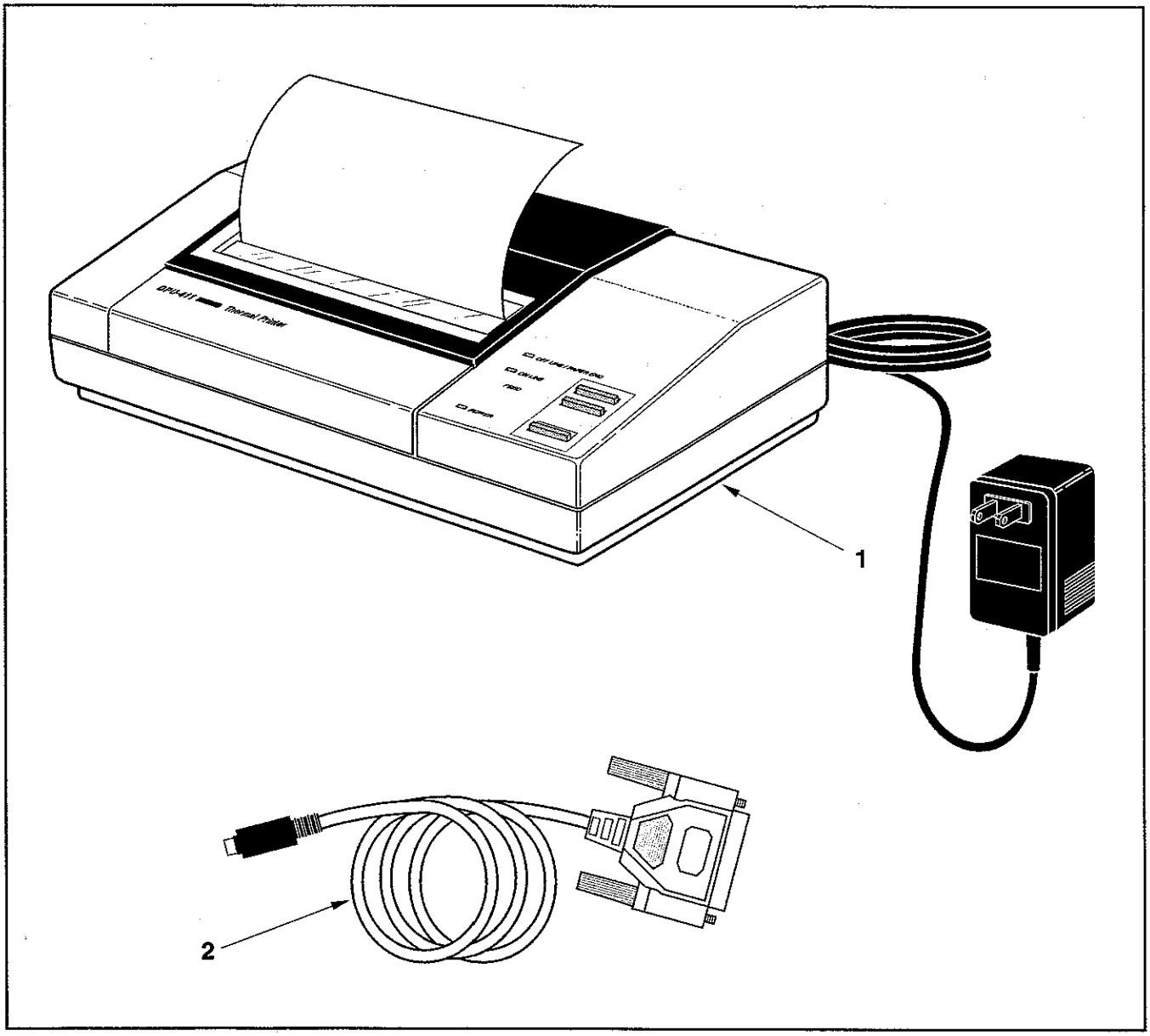

Fig. 1-25 Printer Kit Assembly (P/N 800066 or 800065)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
1-25	800066	Printer Kit Assembly (220 VAC)	Ref.	
-1	800132	Printer	1	
	800117	Cable Assembly, Printer Interface	1	
-2	800065	Printer Kit Assembly (115 VAC)	1	
	800131	Printer	1	
	800117	Cable Assembly, Printer Interface	1	

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
	800771	**CT 9000 ADV Universal Interface Kit**	Ref.	
-1	800891	CT9000 ADV Firmware Upgrade Kit	1	
-2		Screw 4-40 x 1/2 Slotted Pan Head	2	
-3		Nut Hex #6	4	
-4		Lockwasher, Internal Tooth #6	4	
-5		Screw, #6-32 x 3/8 Pan Head Slotted	4	
1-26	800941	PCB Assembly, Interface Board	1	
1-27	800261	Cable Assembly, Picker Interface Internal	1	
1-28	800262	Back Cover Box, Picker Interface	1	

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Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
1-26	800941	Assembly, Universal Interface	Ref.	
-1		PC Board, CT 9000	1	
-2		Relay, DPDT Form C 12 V Coil	8	K1-8
-3		I.C. Schmidt Trigger 74HC14N	3	U2, 3, 5
-4		I.C. Driver Array, ULN 2803A	1	U1
-5		I.C. RS 232 Driver/Receiver	1	U10
-6		I.C. RS 232 Driver/Receiver	1	U15
-7		I.C. DUART, MC68681	1	U4
-8		DC to DC Converter +12 V to -12 V Isolated	1	PWR-1
-9		I.C. Opto-Isolator, #4N35	8	U6-9, 11-
14				
-10		Crystal 3.6864 MHz, Case HC-49/US	1	CX-1
-11		Isolation Transformer, Schott Transformer	1	T1
-12		Capacitor, Ceramic 10pf 100V	1	C18
-13		Capacitor, Tantalum, 1 uF 16V	3	C19, 20, 21
-14		Capacitor, Tantalum, 4.7 uF 25V	7	C1, 2, 6,12, 13,14, 22
-15		Capacitor, Ceramic .1uf 50V	11	C3, 4, 5, 7, 8, 9,10,11, 16, 23
-16		Resistor SIP 1.5Ký 10 Pins 9 Devices	1	RS1
-17		Diode, 1N914	1	D5
-18		Diode, 1N4004	4	D1, 2, 3, 4
-19		Resistor, Carbon Comp 4.7K 1 / 4 5%	4	R9, 10, 11, 12
-20		Resistor, Carbon Comp 4.7K 1 / 4 5%	4	R1, 2, 3, 4
-21		Resistor, Carbon Comp 15K 1 / 4 5%	4	R5, 6, 7, 8
-22		LED, Red T1 3/4.1" Lead Spacing	8	LED1-8
-23		Connector, DB-25	1	J3
-24		Connector, 64 Pin Euro Din, Right Angle, Male	2	J, K
-25		Leadless Chip Carrier Socket 44 Position	1	U4
-26		Terminal, Male .025 S.O., 3 Position	2	JP3, 4
-27		Terminal, Male .025 S.O., 2 Position	2	JP1, 2
-28		Jumper, Terminal 2 Position	3	JP1, 3, 4

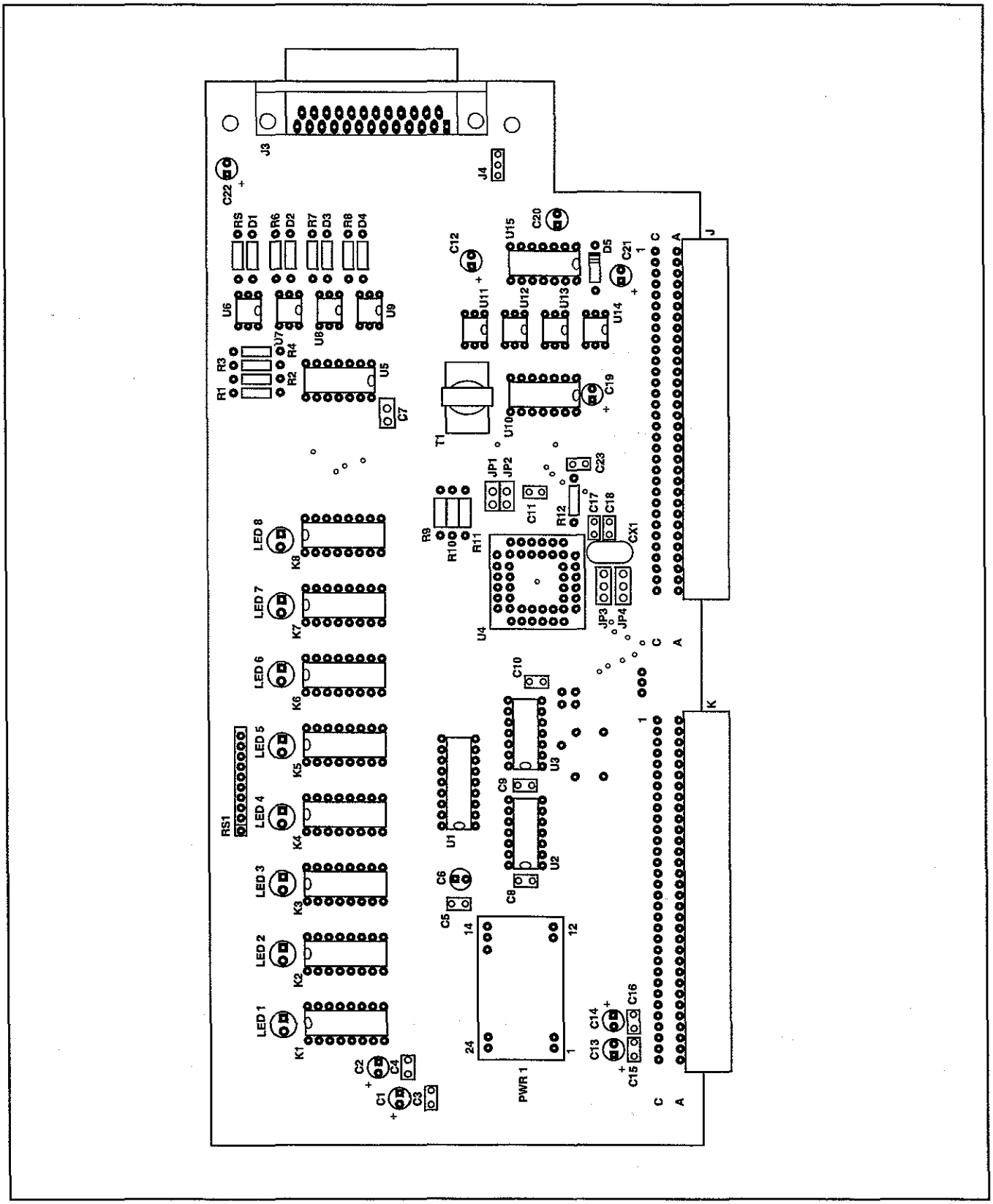

Fig. 1-26 Universal Interface PCB Assembly (P/N 800941)

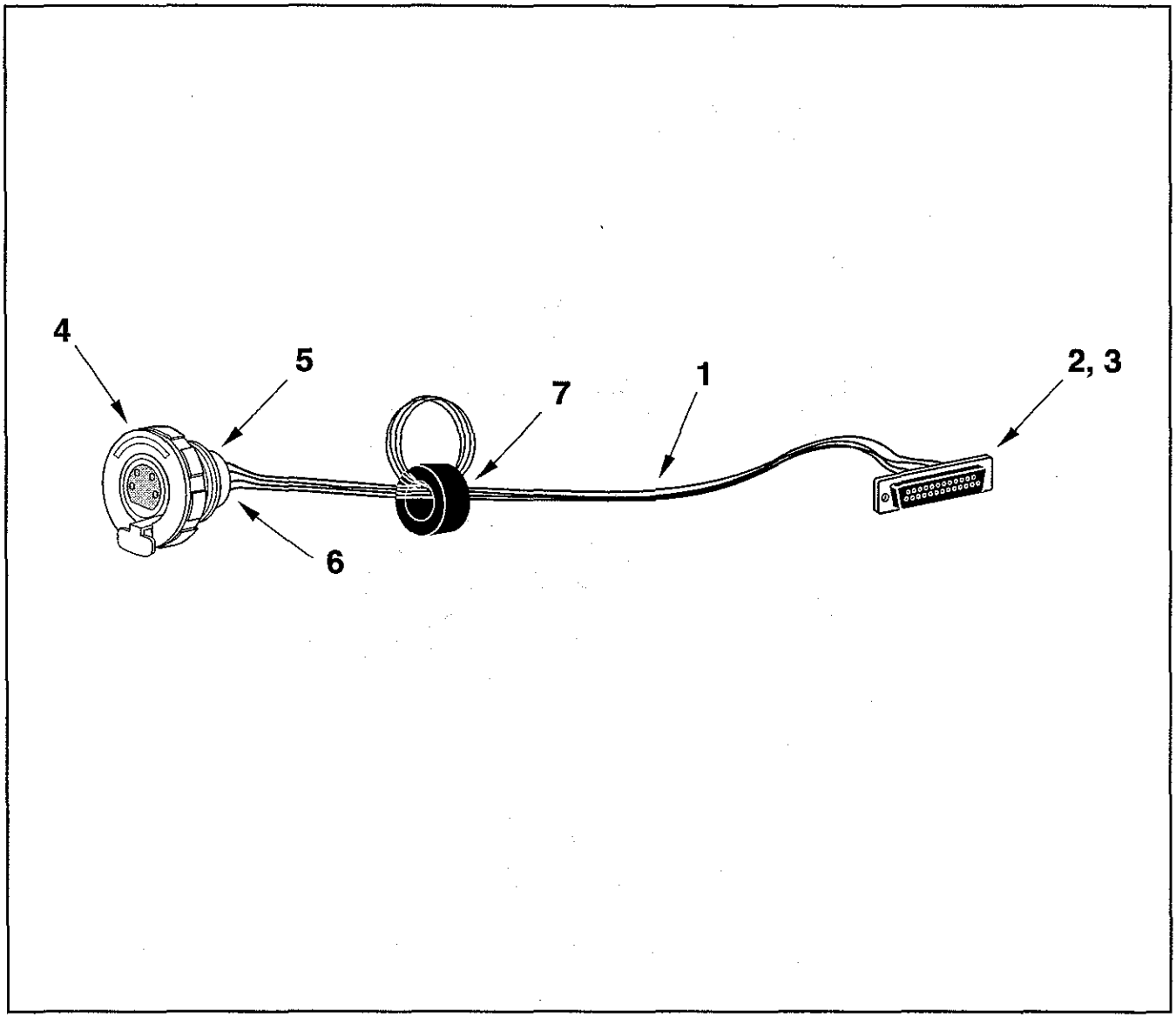

Fig. 1-27 Picker Interface Cable Assembly (P/N 800261)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
1-27	800261	Cable Assembly, Picker Interface	Ref.	
-1		Cable, Flat, 5 COND. 24 AWG.	9 IN.	
-2		Contact, 22 AWG PIN	4	
-3		Connect, 25 Pos. D-Shell (Plug)	1	
-4		Receptacle, 4 Pos.	1	
-5		Resin Core Solder	A.R.	
-6		Tubing, Heat Shrink	2 IN.	
-7		Bead, Shield	1	

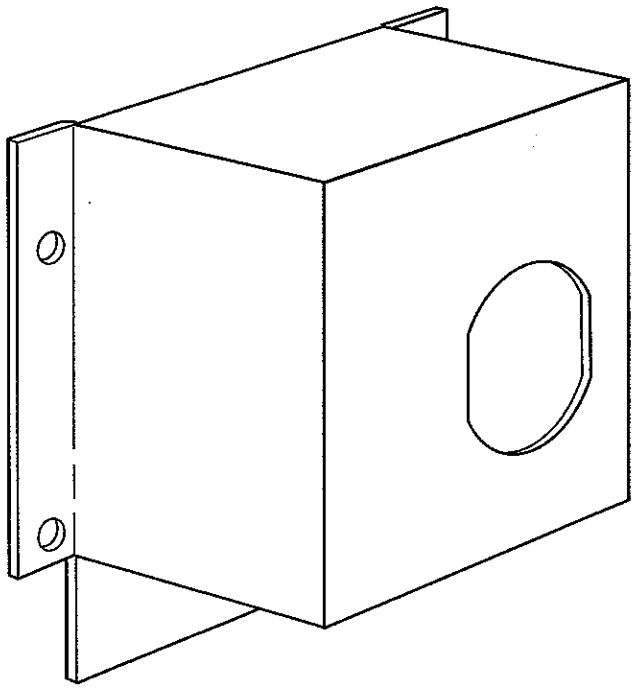

Fig. 1-28 Interface Box (P/N 800262)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
1-28	800262	Box, Interface	Ref.	

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
1-29	800658	Integrated Mounting Stand	Ref.	
-1	800644	Pole Assembly (See Fig. 1-26)	1	
-2	800645	Base, Sub-assembly (See Fig. 1-25)	1	
-3	800151	Power Cord, U.S.	1	
-4	800612	Power Cord, European	1	
-5				
-6	800683	Bracket, Remote Stand	1	
-7		Screw, #8-32 x 3/8 Flat Head	3	

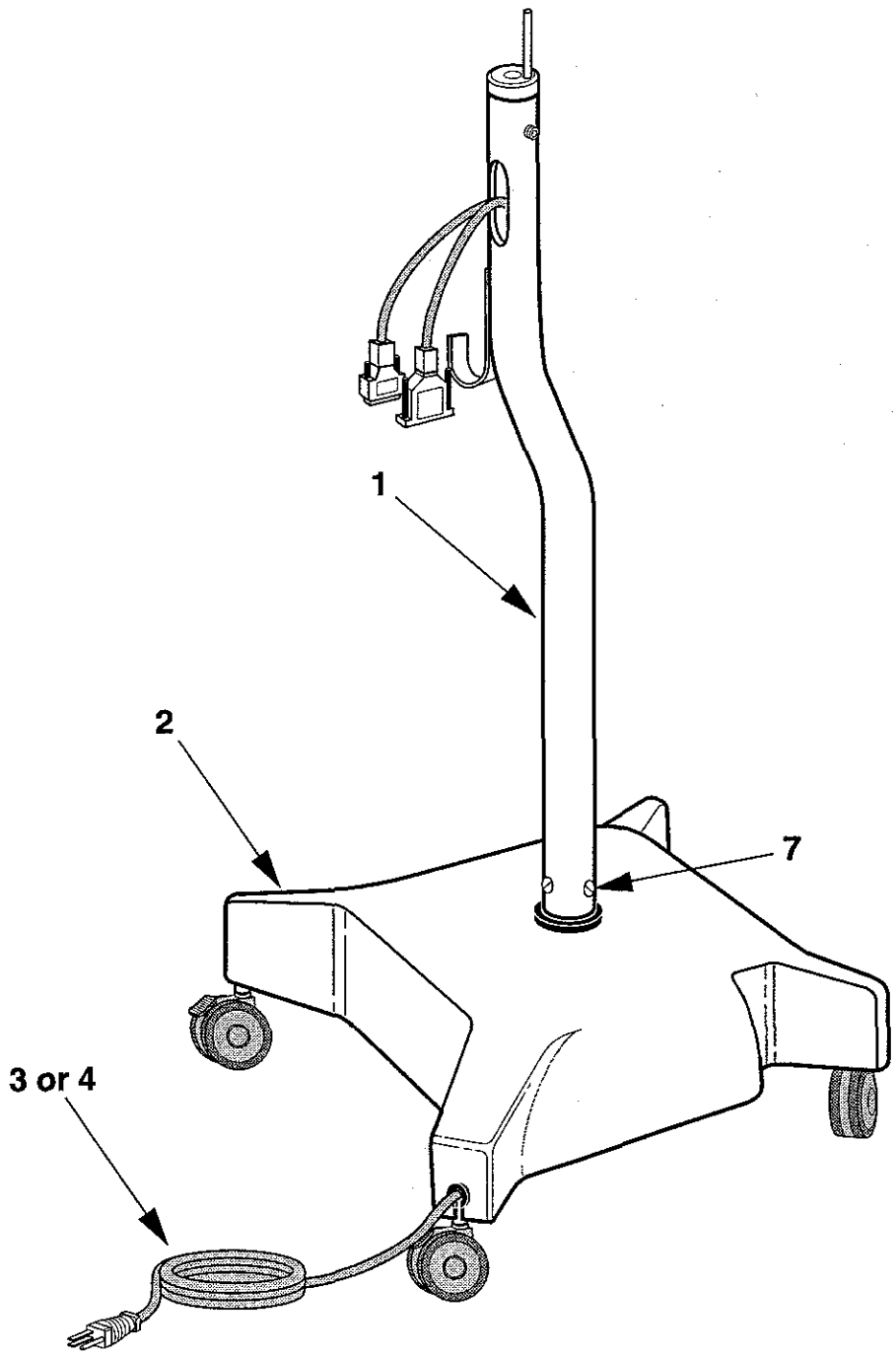

Fig. 1-29 Integrated Mounting Stand (P/N 800658)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
1-30	800645	Base Assembly, Integrated Stand	Ref.	
-1	800605	Base Structure	1	
-2	800614	Castor, Swivel	2	
-3	800613	Castor, Locking	2	
-4	800597	Shell Cover	1	
-5				
-6	209L4	Clamp, Cable - 5/16" #10 Screw	1	
-7		Screw, #8-32 x 3/8 Pan Head	3	
-8	209L3	Clamp, Cable - 1/4" #10 Screw	2	
-9	800609	Grommet, Cord Exit	1	
-10	334309	Velcro Hook, 1" Wide, Black	8"	
-11	334308	Velcro Loop, 1" Wide, Black	8"	
-12	800648	Label, Warning/Spec.	1	
-13	800483	Label, Toggle On/Off	1	

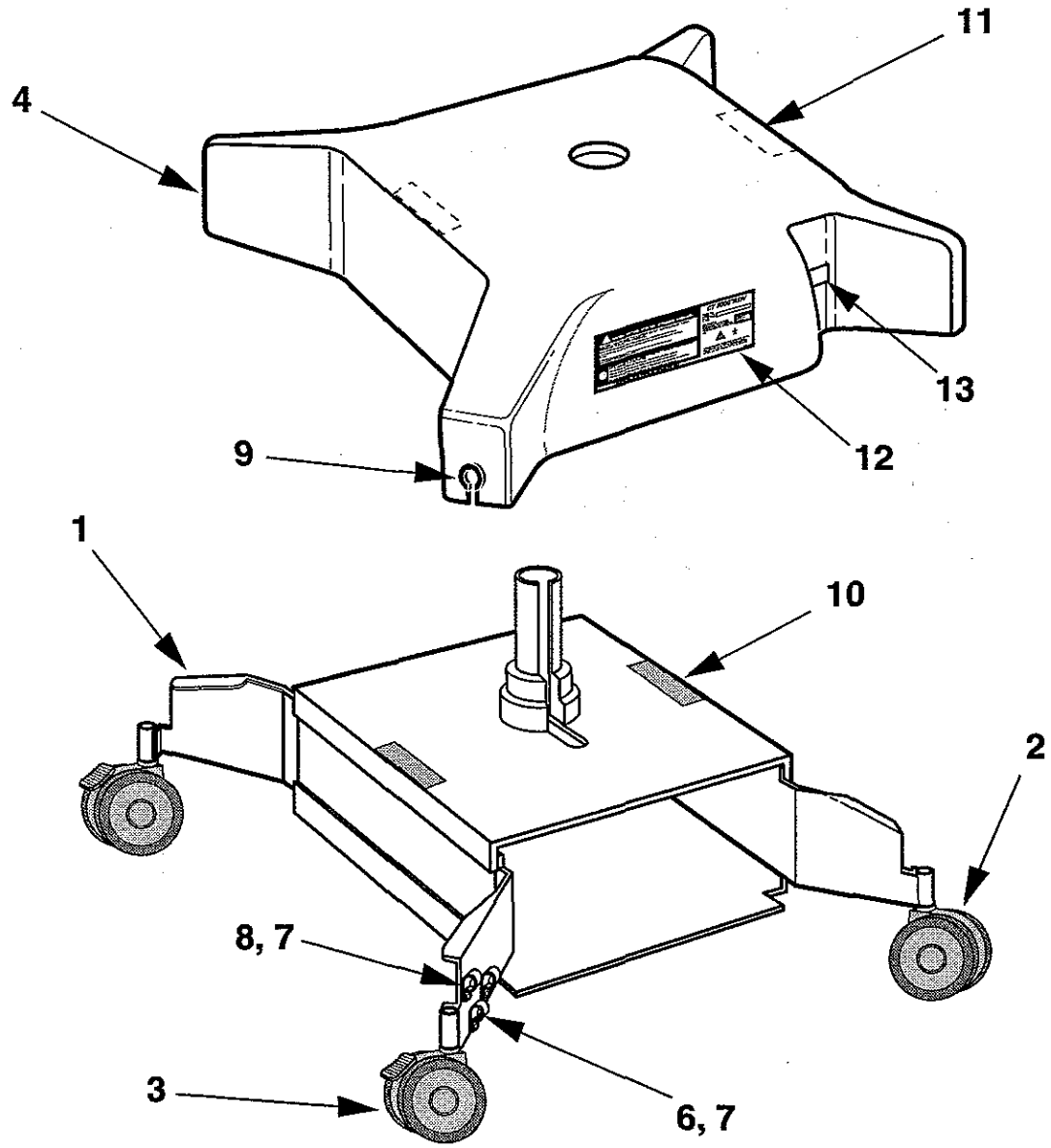

Fig. 1-30 Base Assembly, Integrated Stand (P/N 800645)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
1-31	800644	Pole Assembly, Integrated Stand	Ref.	
-1	800649	Pole, Stand, Bent	1	
-2	800599	Cable, 25 Pin, 6'	1	
-3	800598	Cable, 15 Pin, 6'	1	
-4				
-5				
-6	800657	Pivot Attachment Collar	1	
-7	800529	Pin	1	
-8	800535	Washer, Neoprene	1	
-9		Screw, 8-32 x 3/8" Slotted Flt. Head	2	
-10				
-11	800507	Plug, Equipotential	1	
-12		Washer, Lock, 1/4" Steel	1	
-13	800530	Label, Equipotential	1	
-14	800687	Pole Base Grommet	1	
-15	800686	Bottom Clamping Grommet	1	
-16	800693	Top Clamping Grommet	1	
-17		Screw, Painted #6	4	

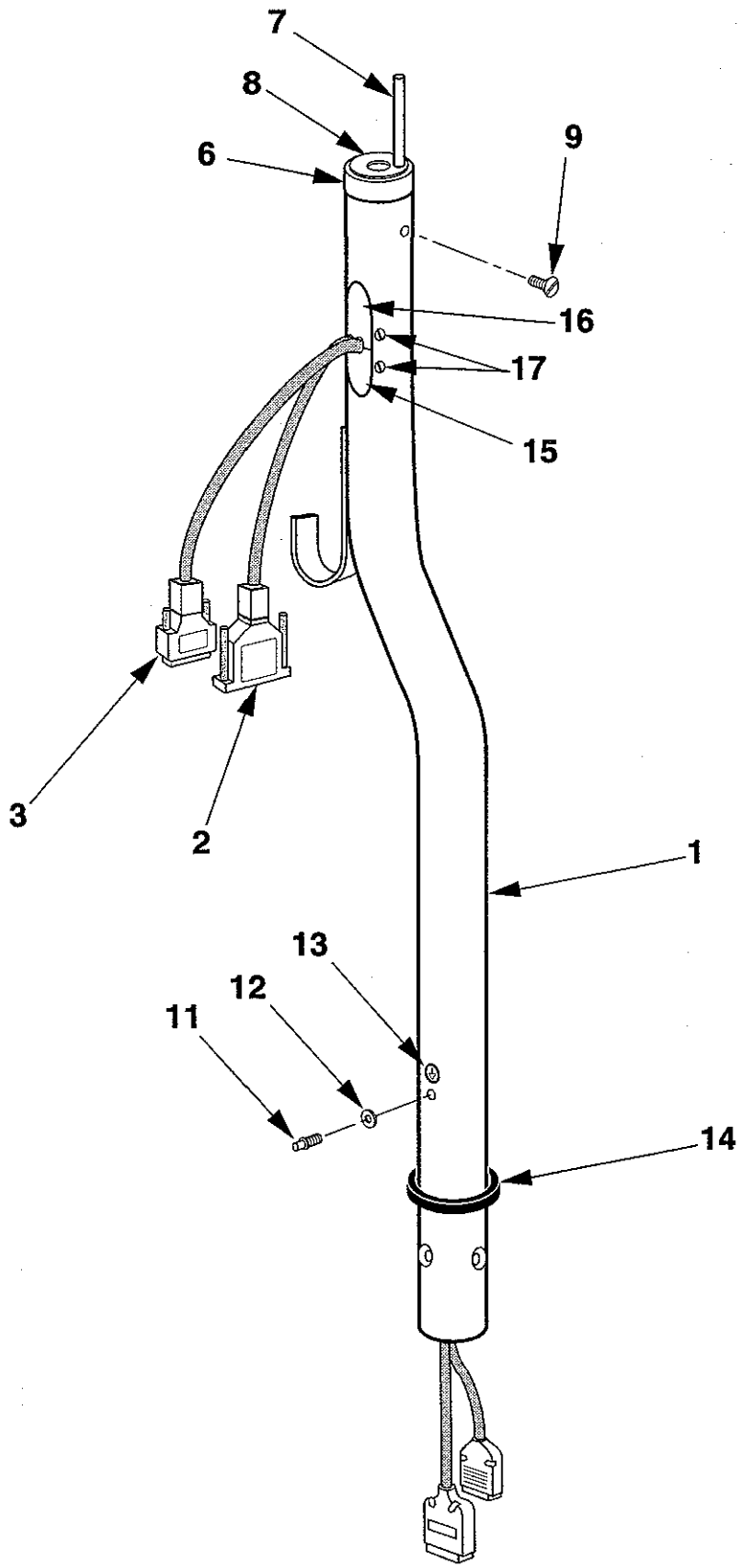

Fig. 1-31 Pole Assembly, Integrated Stand (P/N 800644)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
1-32	800665	Pole Assy., I.V. (Optional)	Ref.	
-1	243191	Handle, Rod End	1	
-2	800662	Base, I.V. Pole	1	
-3	800663	Pole, I.V.	1	
-4	800664	Label, I.V. Pole	1	

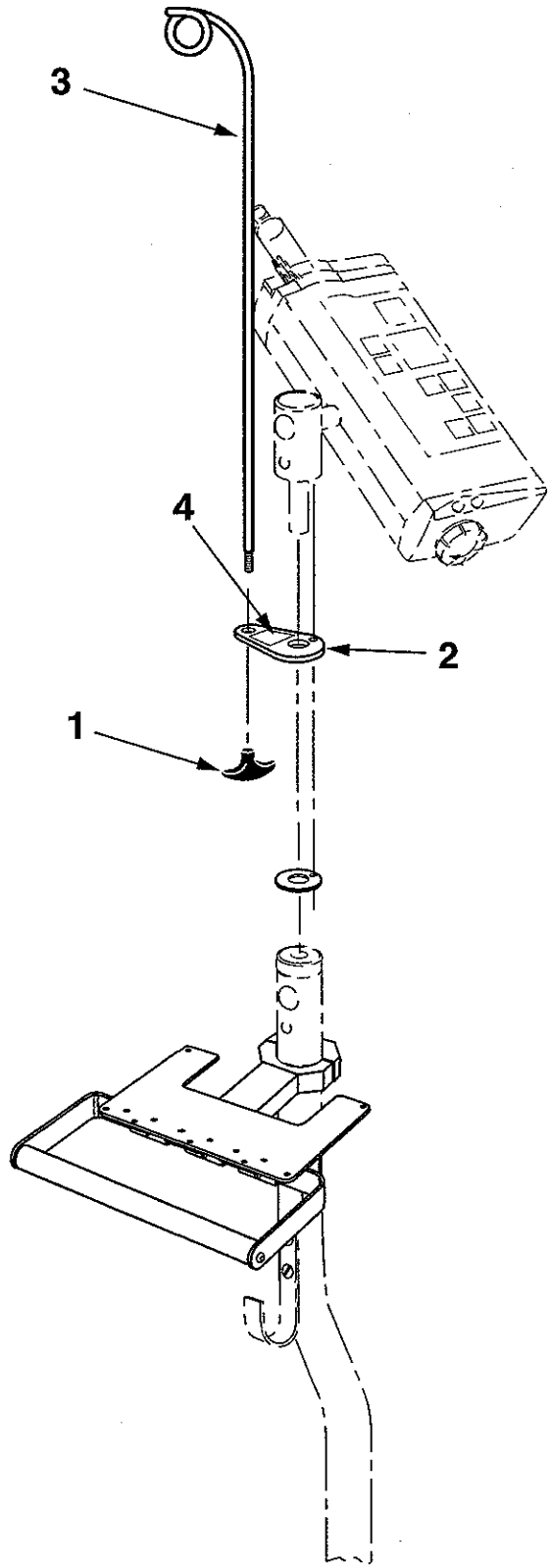

Fig. 1-32 Pole Assembly, I.V. (Optional) (P/N 800665)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
1-33	Ref.	Integrated Mounting Stand - Complete	Ref.	
-1	800017	Console Assembly (See Fig. 4-1)	1	
-2	800740	Powerhead Assembly (See Fig. 3-1)	1	
-3	800658	Integrated Mounting Stand	1	

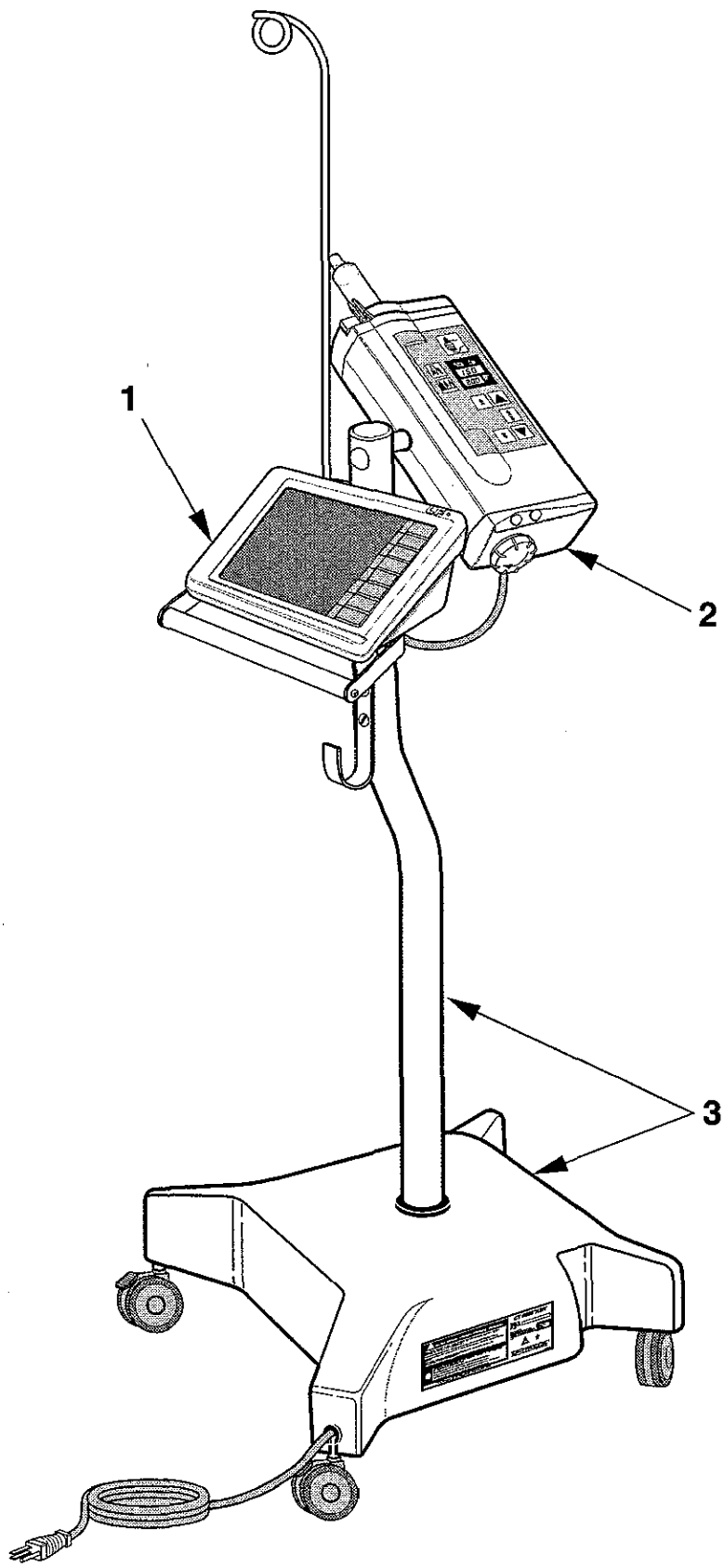

Fig. 1-33 Integrated Mounting Stand - Complete Unit

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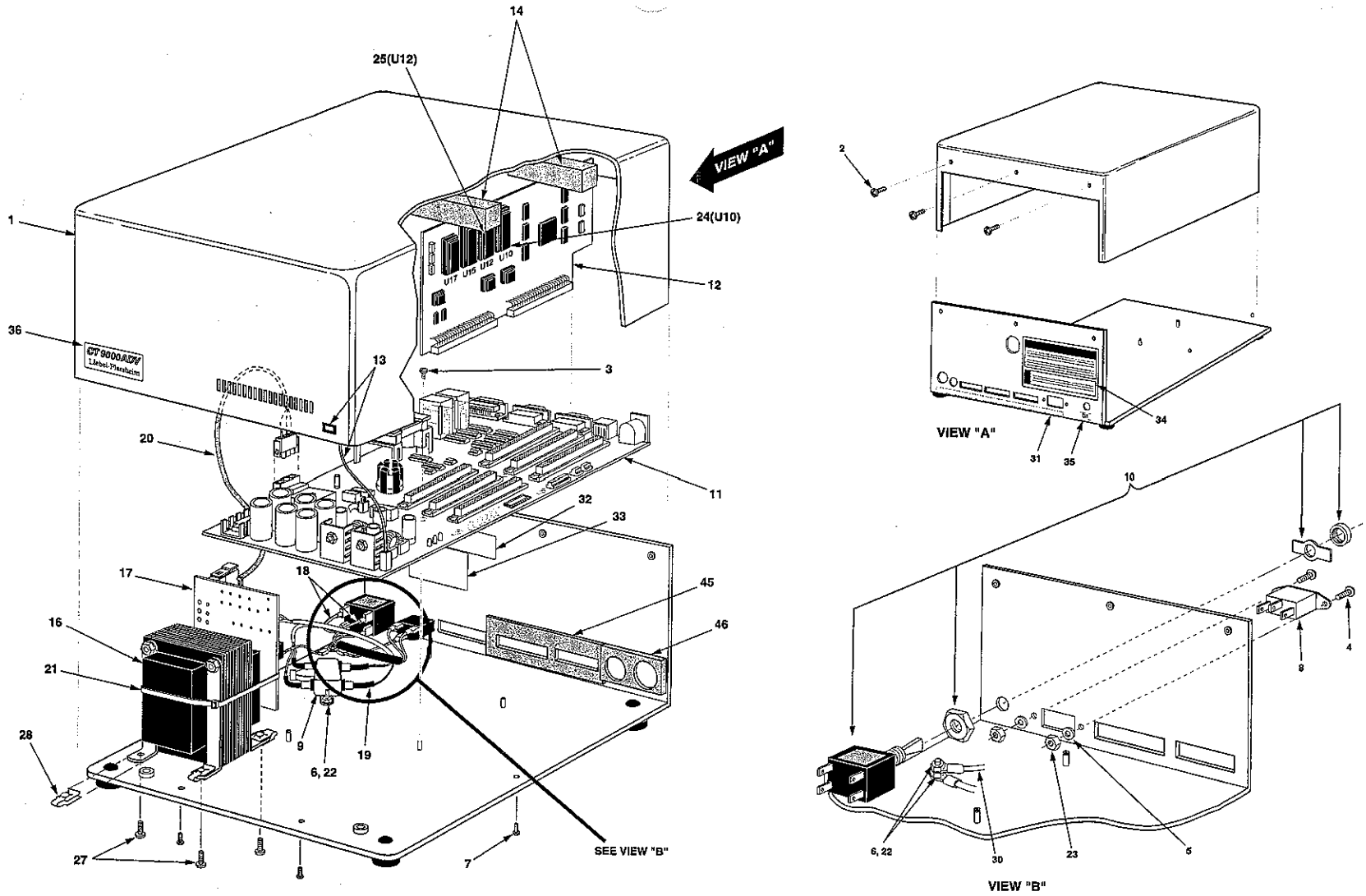
SECTION II
POWER PACK ASSEMBLY

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
2-1	800670	Power Pack Assembly	Ref.	
-1	800770	Power Pack Enclosure	1	
-2		Screw, 6-32 x 1/4"	3	
-3		Screw, Sems External Tooth Lock	1	
-4		Screw, #4-40 x 3/8" F. H.	2	
-5		Washer, #4 Lock Internal Tooth	2	
-6		Washer, #6 Lock Internal Tooth	4	
-7		Screw, 6-32 Hex Washer	5	
-8	240E0379	Entry Module, VAC IEC Type	1	
-9	332E0001	Filter, Line	1	
-10	170E0021	Circuit Breaker, On-Off Switch	1	
-11	800906	PCB Assembly, Mother (See Fig. 2-2)	1	
-12	800902	PCB Assembly, CPU (See Fig. 2-4)	1	
-13	800914	Power Light Assembly	1	
-14	800757	PCB Support	2	
-15				
-16	850E0029	Transformer	1	
-17	800908	PCB Assembly, Voltage Select (See Fig. 2-3)	1	
-18	800915	Cable Assembly, Power Entry	2	
-19	800917	Cable Assembly, Filter to Voltage Board	1	
-20	800916	Cable Assembly, Secondary Power	1	
-21		Tie, Cable	1	
-22		Nut, #6-32 Hex	4	
-23		Nut, #4-40 Hex	2	
-24	8001009	Firmware, System Program	1	
-25	8001008	Firmware, System Language	1	
-26				
-27		Screw, 10-32 x 1/2"	4	
-28		Nut "U" Type	4	
-29				
-30	800899	Lead Assembly, Ground	2	
-31		Label, Connector Plate	1	
-32		Label, Fuse Replacement	1	
-33		Label, High Voltage Warning	1	
-34		Label, Shock & Explosion Warning	1	
-35		Label, Toggle On-Off	1	
-36		Label, CT9000 Liebel-Flarsheim	1	
-37		Ty-Rap Tie	1	
-38		Ty-Rap Mount	1	
-39		Label, CSA Logo	1	
-42		UL Label	1	
-45	800987	Gasket, Powerpack Enclosure	1	
-46	800986	Gasket, Powerpack Enclosure	1	



800961-C Sept 2000

Fig. 2-1 Power Rack Assembly (P/N 800670)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
2-2	800906	PCB Assembly, Mother	Ref.	
-1		PCB, Servo-Mother Board	1	
-2				
-3		IC Opto-Isolator PS2505-2	3	U1,2,7
-4				
-5		IC Opto-Isolator PC824	1	U18
-6		IC Schmidt Trigger 74HC14	1	U3
-7		IC Transmitter 34C87	1	U4
-8		IC Receiver 34C86	1	U13
-9		IC Flip-Flop 74HC109	1	U14
-10		IC Quad AND Gate 74HC08	1	U6
-11		IC Pulse Width Modulator UC3525	1	U16
-12		IC NAND Gate 74HC00	1	U5
-13		IC Op-Amp LM358	2	U9,11
-14		IC Comparator LM339	1	U10
-15		IC Dual Digital Pot. DS1267-10	1	U8
-16		IC Driver Array MC1416	2	U15,19
-17		IC Micro Manager Chip DS1238	1	U22
-18		IC Dual Multi Vibrator 74HC4538	1	U23
-19		IC Flip-Flop 74HC45109	1	U21
-20				
-21		Diode, Ultrafast 8 Amp MUR840	4	D1,2,5,7
-22		Diode, Zener 1N5388B	1	D9
-23		Diode, 1N914	4	D4,11,10,13
-25		Diode, Zener 1N4740	1	D8
-26				
-27		Diode, 1N4004	2	D3,12
-28		Bridge Rectifier MB152W	1	BR1
-29		Screw, #2-56 x 1/4", P.H.	12	J6-8,K9-11
-30		Nut, #2-56, Hex	12	J6-8,K9-11
-31		Choke, 55µh	2	L1,2
-32				
-33		Filter, EMI Ferrite	8	EF1-8
-34				
-35		Voltage Regulator, LT1074	2	VR1&2
-36		Voltage Regulator, LM317LZ	1	VR3
-37				
-38		MOV, GE V150LA10A	2	MOV1,2
-40		Transistor, 2N3904	1	Q3

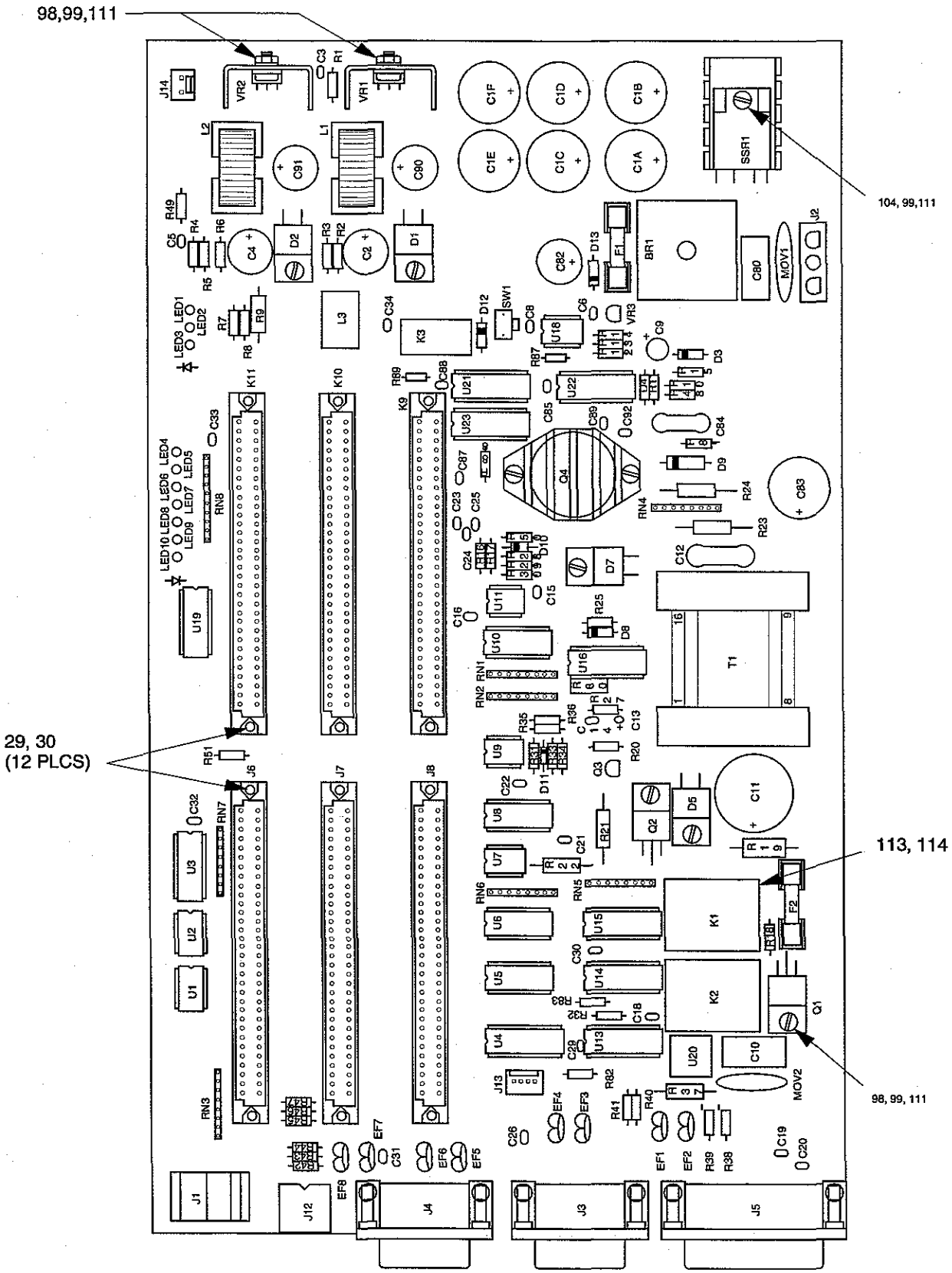


Fig. 2-2 PCB Assembly, Mother (P/N 800906)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
2-2	800906	PCB Assembly, Mother	Ref.	
-41		Transistor, IRF240	1	Q4
-42		Transistor, IRF740	2	Q2
-43		Triac, High Voltage T2800	1	Q1
-44				
-45		Relay, Solid State, Sharp #S202S12	1	SSR1
-46				
-47		Capacitor, Ceramic .001µf	1	C14
-48		Capacitor, Electrolytic 47µf 50VDC	1	C9
-49		Capacitor, Ceramic .1µf	26	C3,6,5,8,15
-50				16,18,19,20
-51				21,23,24,25
-52				26,29-36,85
-53				88,89,92
-54		Resistor, 5.1K, 1/4W, 5%	1	R27
-55		Capacitor, Electrolytic 1000µf 50VDC	6	C1A,1B,1C,1D,
-56				1E,1F
-57		Capacitor, Electrolytic 1000µf 16VDC	2	C2,4
-58		Capacitor, Electrolytic 220µf 50VDC	3	C83,90,91
-59		Capacitor, 2200pf, 500V, Mica	1	C84
-60		Capacitor, Electrolytic 47µf 450VDC	1	C11
-61		Capacitor, .1µf 250VDC	2	C10, 80
-62		Capacitor, 1µf Tantalum 25VDC	5	C13,22, 82,
				87,88
-63		Capacitor, 10,000pf 500VDC Mica	1	C12
-64		Resistor, 5.6K 1/4W 5%	1	R33
-65		Resistor, 10ý 1/4W 5%	6	R25,40,41,43
-66				44,50
-67		Resistor, 220ý 1/4W 5%	5	R37-39,42,86
-68		Resistor, 1K 1/4W 5%	5	R8,16
-69				29,35,36
-70		Resistor, 47ý 1/4W 5%	3	R45,46,47
-71		Resistor, 2K 1/4W 5%	3	R17,1,4
-72		Resistor, 330ý 1/4W 5%	2	R7,49
-73		Resistor, 4.7K 1/4W 5%	3	R32,48,89
-74		Resistor, 10K, 1/4W 5%	2	R12,30
-75		Resistor, 10K, 1/4W 5%	1	R87
-76		Resistor, 180ý 1/4W 5%	1	R20
-77		Resistor, 68ý 1/4W 5%	1	R18
-78		Resistor, 5K Pot.	1	R80
-79		Resistor, 1M 1/4W 5%	2	R28,34

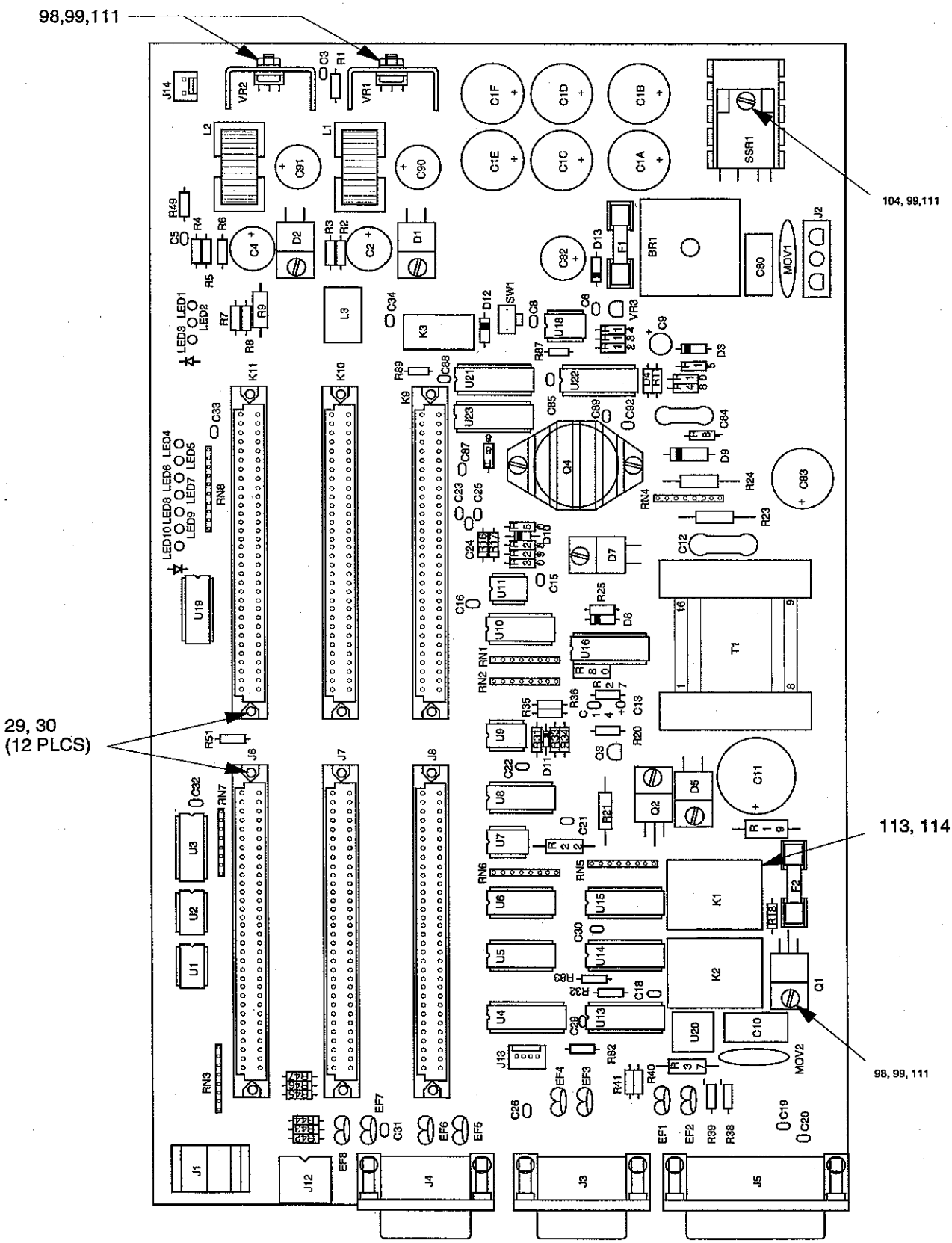


Fig. 2-2 PCB Assembly, Mother (P/N 800906)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
2-2	800906	PCB Assembly, Mother	Ref.	
-80		Resistor, 3.3K 1/4W 5%	1	R31
-81		Resistor, 270ý 1/4W 5%	1	R15
-82		Resistor, 680ý 1/4W 5%	1	R14
-83		Resistor, 1.5K 1/4W 5%	1	R13
-84		Resistor, 100ý, 1/4W, 5%	2	R11,81
-85		Resistor, 100K 1/4W 5%	1	R51
-86		Resistor, 33K, 1/4W, 5%	2	R82,83
-87		Resistor, .1ý, 3W, 1%	1	R24
-88		Resistor, 10K, 3W 5%	1	R23
-89		Resistor, .5ý 3W 1%	1	R19
-90		Resistor, 510ý 1/2W	1	R22
-91		Resistor, 1ý 1W	1	R21
-92		Resistor, 2.7K 1/2W	1	R9
-93		Resistor, 6.65K 1% 1/4W	1	R10
-94		Resistor, 910K 5% 1/4W	1	R88
-95		Resistor, 2.87K 1% 1/4W	1	R6
-96		Resistor, 2.21K 1% 1/4W	2	R2,5
-97		Resistor, 9.76K 1% 1/4W	1	R3
-98		Screw, #4-40 x 5/16" Pan Head	8	
-99		Nut, Hex #4-40	11	
-100		Socket, IC 14-Pin	5	U3,5,6,8,10
-101		Socket, IC 8-Pin	7	U1,2,7,9
-102				11,18,20
-103		Socket, IC 16-Pin	7	U4,13-16,19
-104		Screw, #4-40 x 1/2" Pan Head	3	
-105		Resisitor, SIP 390ý	1	RN8
-106		Resistor, SIP 1K	3	RN3,6,7
-107		Resistor, SIP 4.7K	1	RN1
-108		Resistor, SIP 1M	1	RN2
-109		Resistor, SIP 33K	2	RN4,5
-110		Relay, PC Board Mount	1	K3
-111		Lockwasher, #4 Internal Tooth	13	
-112		Transformer, VDE Flyback	1	T1
-113		Relay, DPDT 2 Form C	2	K1,2
-114		Socket, Relay With Clip	2	K1,2
-115				
-116		LED, Red	10	LED1-10
-117		Heatsink, TO-3	1	Q4
-118		Heatsink, TO-220	1	SSR1
-119		Heatsink, TO-220	2	VR1,2

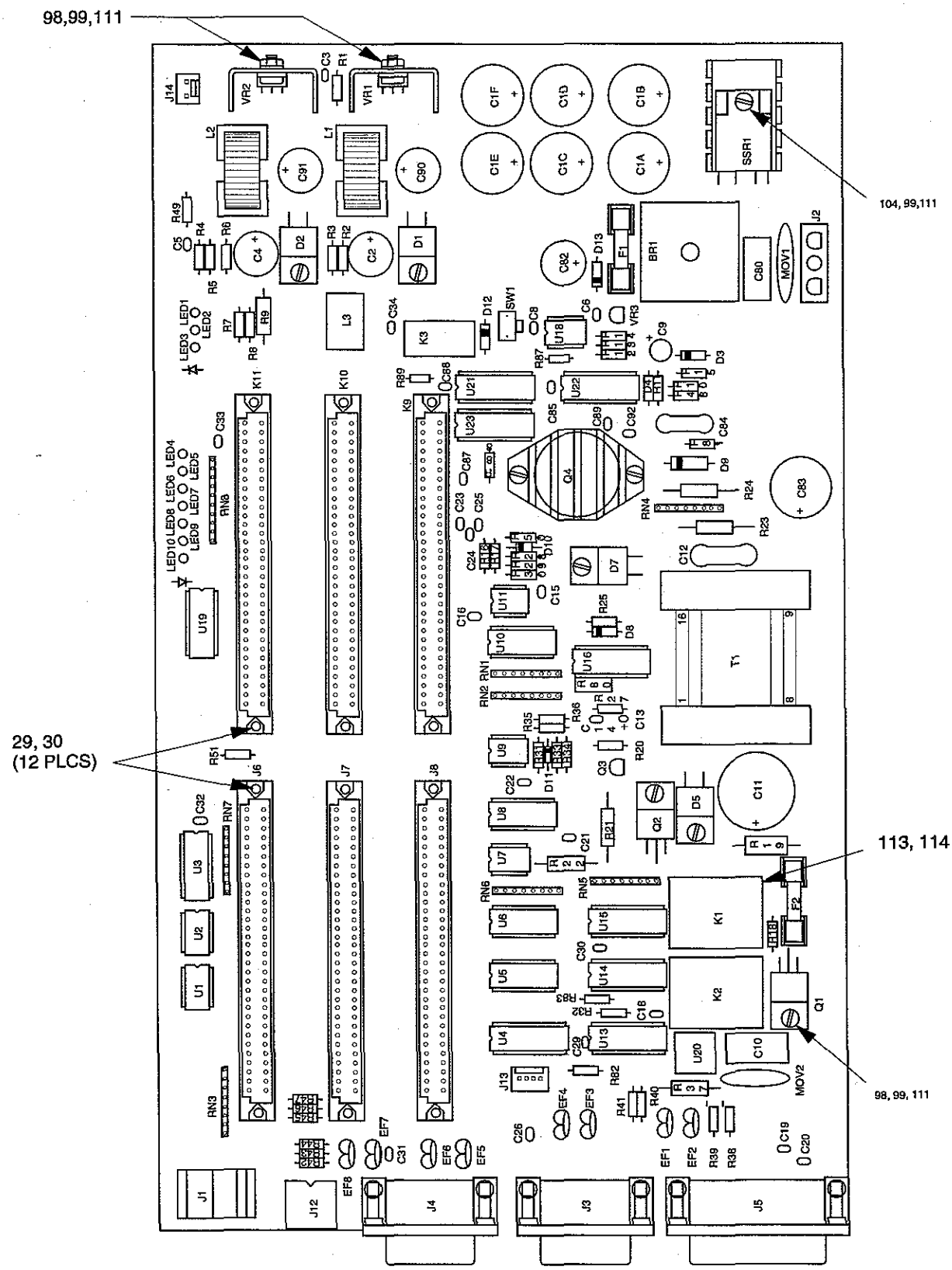


Fig. 2-2 PCB Assembly, Mother (P/N 800906)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
2-2	800906	PCB Assembly, Mother	Ref.	
-120		Choke, Dual Coil	1	L3
-121	172E0016	Fuse, 6.3 AMP 5 x 20 mm	1	F1
-122	172E0057	Fuse, 3.15 AMP 5 x 20 mm	1	F2
-123		Fuse Clip, PCB Mount 5 mm	2	F1,F2
-124				
-125	240E0253	Screwlock, Female	3	
-126		Connector, 25-Pin D-Shell	1	J5
-127		Connector, 15-Pin D-Shell	2	J3,4
-128				
-129		Connector, 8-Pin Cicular Euro-DIN	1	J1
-130		Connector, 8-Pin Circular Mini-DIN	1	J12
-131		Connector, 64-Pin Euro-DIN	6	J6,7,8; K9
-132				K10,11
-133		Connector, 4-Pin Header MTE	1	J13
-134		Connector, 3-Pin Header	1	J2
-135		Connector, 2-Pin Header	1	J14

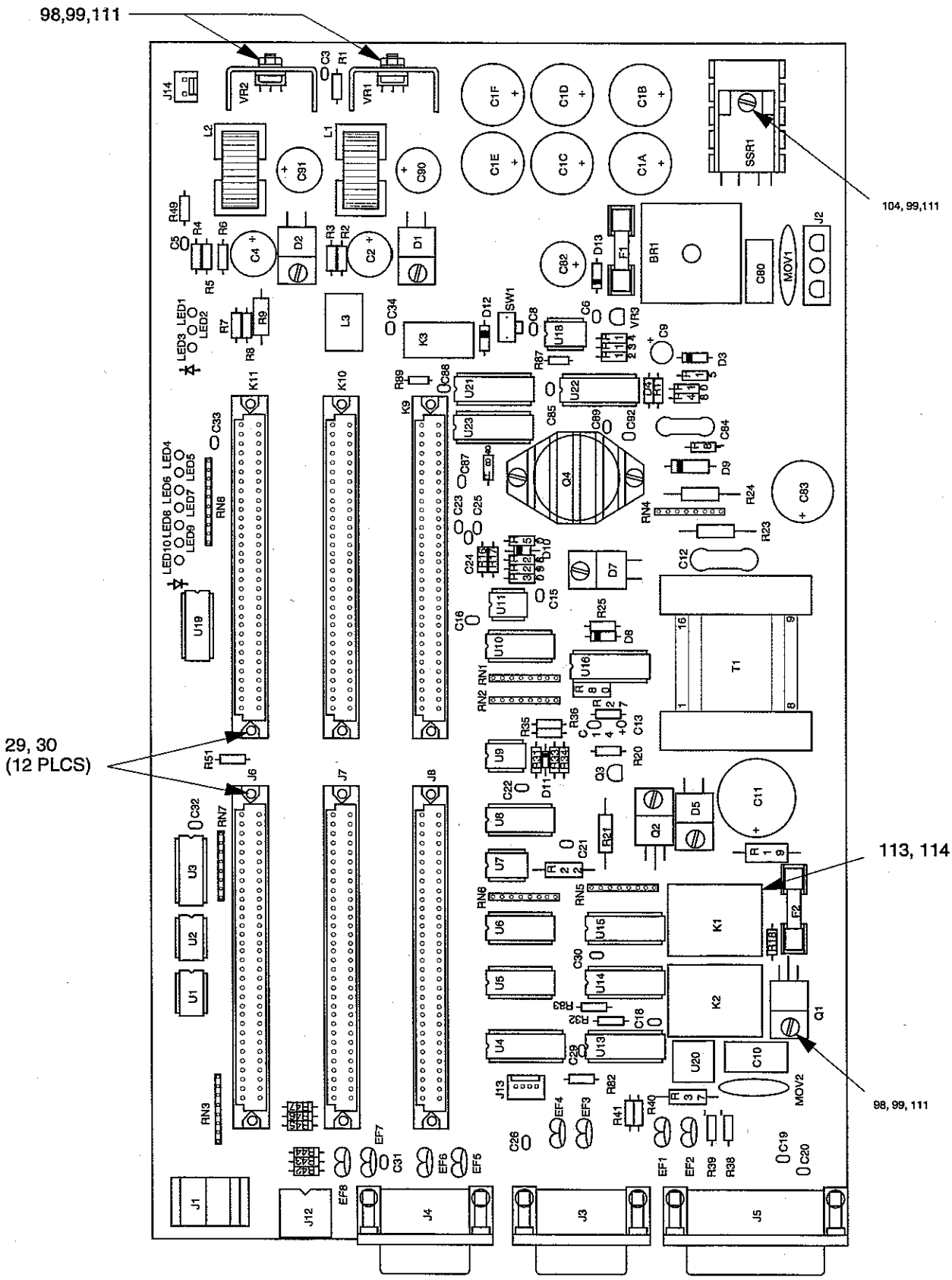
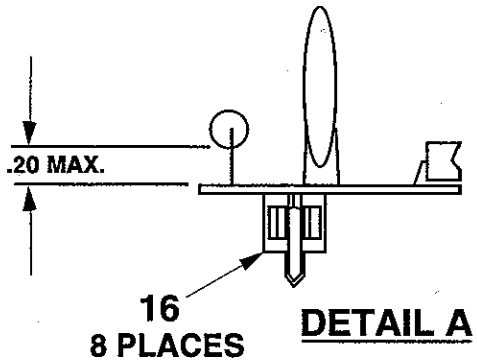
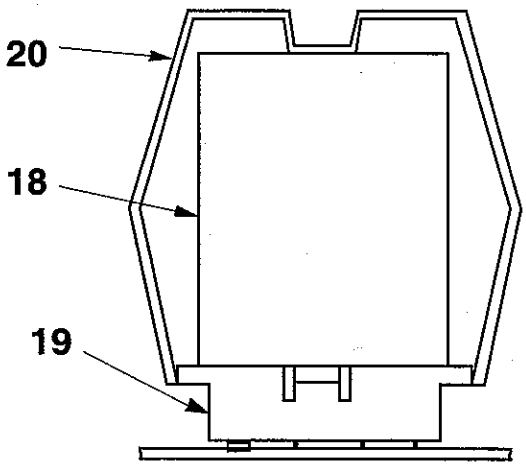


Fig. 2-2 PCB Assembly, Mother (P/N 800906)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
2-3	800908	PCB Assembly, Voltage Select	Ref.	
-1		PCB, Voltage Selection Board	1	
-2				
-3		Resistor, 100ý, 1 W, 5%	1	R1
-4		Resistor, 15K, 3W, 5%	1	R2
-5		Resistor, 82K, 1/2W, 5%	1	R3
-6		Resistor, 2.4K, 1/4W, 5%	1	R4
-7		Resistor, 3.3K, 1/4W, 5%	1	R5
-8		Resistor, 10K, 1/4W, 5%	1	R6
-9		Resistor, 62ý, 1/4W, 5%	1	R7
-10		Varistor, 175V, 1W	1	MOV1
-11				
-12		IC, Voltage Sensing Device, MC34064P-5	1	U1
-13				
-14		Connector, Header 2-Position	1	J16
-15		Connector, Header 3-Position	1	J15
-16		Terminal, Faston Receptacle .250, PCB	8	TR1,2,5,6 7,8,11,12
-17				
-18		Relay, DPDT, 110VDC Power	1	K1
-19		Socket, Relay, 8-Pin, DPDT	1	K1
-20		Clip, Relay Socket	1	K1
-21				
-22		Transistor, NPN, 2N3904	1	Q1
-23		Transistor, NPN, MPSW42	1	Q2
-24				
-25		Capacitor, 2.2uf, 250V, Axial, A.E.	1	C1
-26		Capacitor, 10uf, 20V, Tantalum	1	C2
-27		Capacitor, 1uf, 25V, Tantalum	1	C3
-28				
-29		Diode, 1N4004	1	D1
-30		Diode, Zener 6.2V, 1N4735, 1W	2	DZ1,DZ2
-31				
-32		Bridge Diode, DIP Package	1	BR1
-33				
-34		Resistor, 10ý, 10W, 5%	1	R8



DETAIL A



DETAIL B

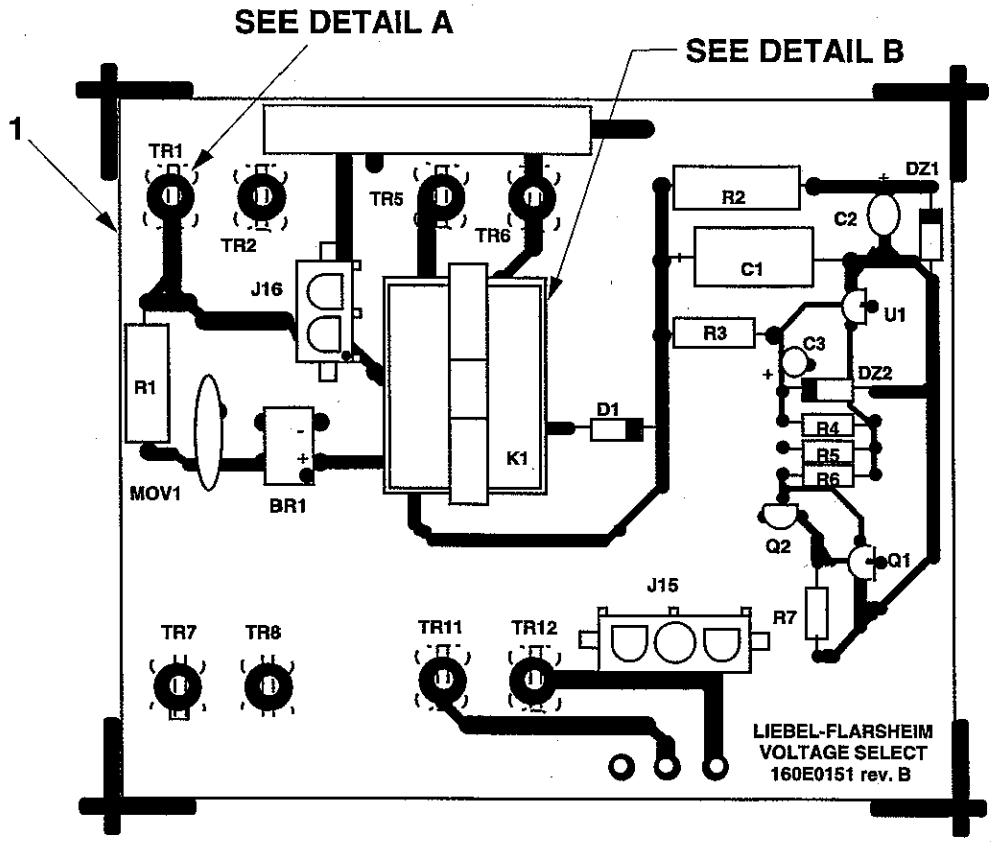


Fig. 2-3 PCB Assembly, Voltage Select (P/N 800908)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
2-4	800902	PCB Assembly, CPU	Ref.	
-1	*	IC Socket 32-Pin DIP	3	U10, 12
		*** Contained in CT 9000 ADV Software Upgrade Kit LF P/N 800891**		

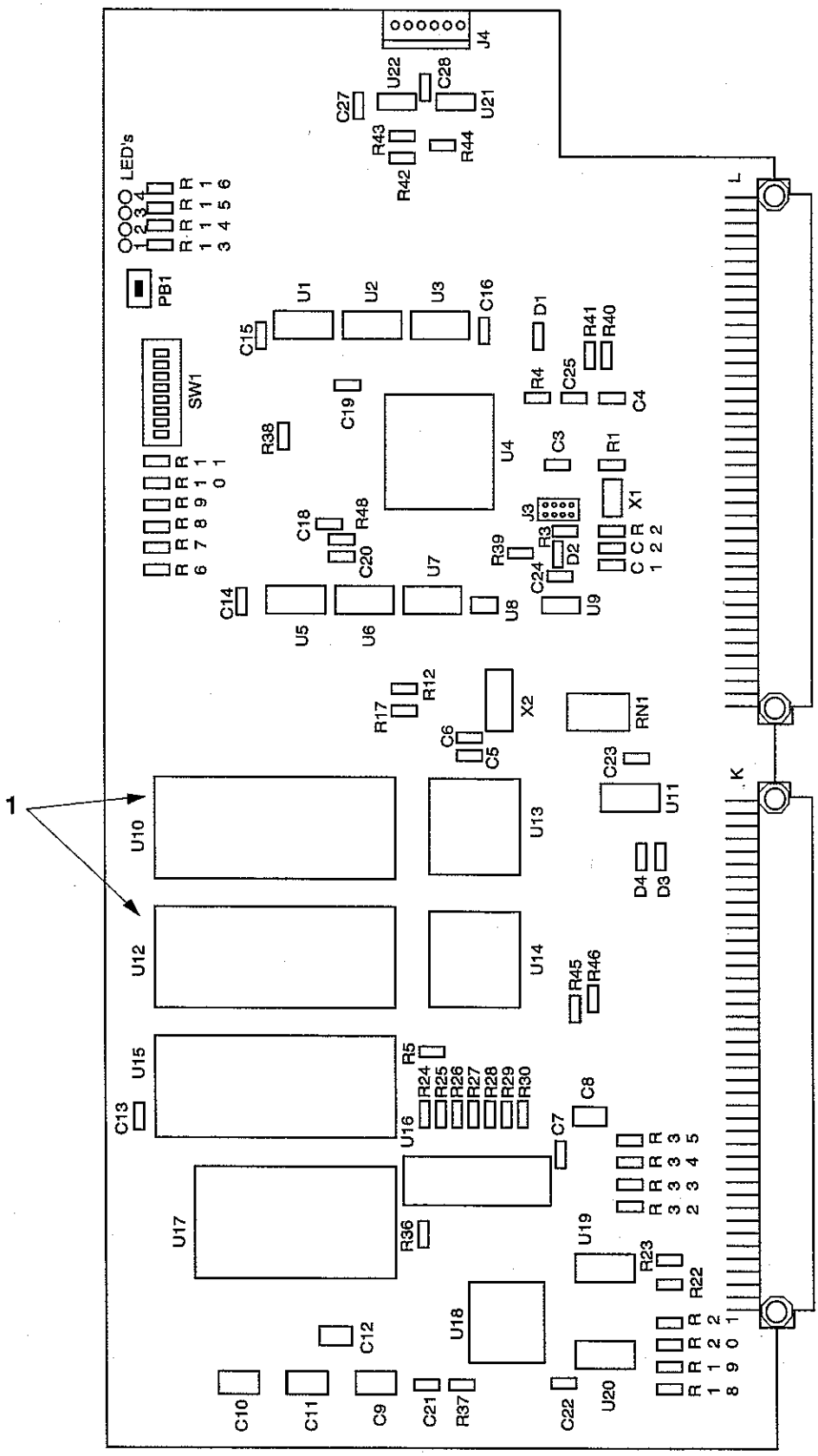


Fig. 2-4 PCB Assembly, CPU (P/N 800902)

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SECTION III A
POWERHEAD ASSEMBLY
With Manual Knob (Current Design)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
3-1	800740	Power Head Assembly	Ref.	
-1	800741	Main Frame Assembly (See Fig. 3-2A, 3-2B)	1	
-2	800692	Bracket, Keyboard, Display	1	
-3	800739	End Cap Assembly (See Fig. 3-4)	1	
-4	800742	Motor and Encoder Assembly (See Fig. 3-5)	1	
-5	800769	Harness Assembly, Motor Encoder	1	
-6	800313	Top Cover, Finished	1	
-7	800408	Bottom Cover Assembly	1	
-8	800567	Keyboard	1	
-9	800409	Connector Plate Assembly	1	
-10		Screw, #2-56 x .25" Soc. Hd. Cap	2	
-11		Washer, #8 Rubber	4	
-12	388E0084	Spacer, #8 Clearance x 1/4"	2	
-13		Washer, #2 Lock	2	
-14	903085	Pot Assembly, Slide	1	
-15		Screw, #2-56 x .312" P. H.	2	
-16	800562	PCB Assembly, Powerhead (See Fig. 3-6)	1	
-17		Nut, #2-56 Hex	2	
-18		Screw, #8-32 x 1 3/4" Phillips P.H.	3	
-19				
-20		Screw, #6-32 x 5/8" F. H.	2	
-21		Gasket Material	A.R.	
-22		Nut, Nylok, #8-32 Hex	4	
-23		Part & Serial Number Plate	1	
-24		Washer, Brass	4	
-25		Label, IEC Risk Class	1	
-26		Screw SHCS #8-32 x 1.37	3	
-27		Washer, Ext Tooth Lock	4	
-28	800568	P.C.B. Assembly, Display Powerhead	1	
-29	600694	Cable, Ribbon 10 Pin	1	
-30	249937	Cable, Ribbon 16 Pin	1	
-31		Lockwasher, #6 Internal Tooth	2	
-32		Screw, Pan Head #6-32 x 3/8"	3	
-33				
-34	800745	Knob, Mechanical	1	
-35				
-37		Screw, 6-32 x 3/4"	1	
-38	388E0112	Standoff, .177 x 7/16"	1	
-39		Washer	2	

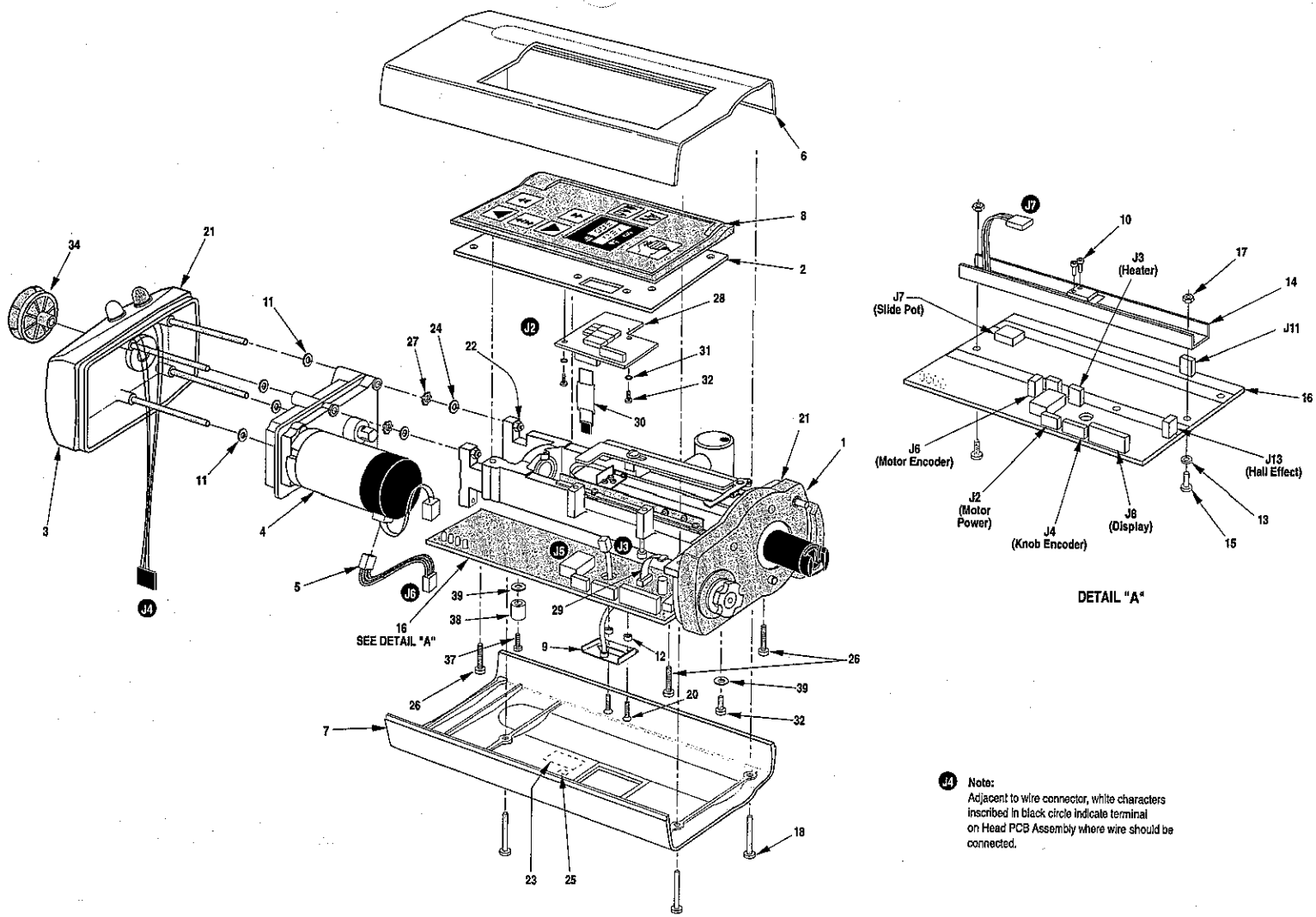
SEE DETAIL "A"
DETAIL "A"
J7 (Slide Pot)
J3 (Heater)
J6 (Motor Encoder)
J2 (Motor Power)
J4 (Knob Encoder)
J8 (Display)
J13 (Hall Effect)
J4 Note:
Adjacent to wire connector, white characters inscribed in black circle indicate terminal on Head PCB Assembly where wire should be connected.

Fig. 3-1 Powerhead Assembly (P/N 800740)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
3-2	800741	Main Frame Assembly	Ref.	
-1	800318	Main Frame (Finished)	1	a
-2	800768	Ram Assembly (See Fig. 3-3)	1	a
-3	800580	Bushing	1	a
-4	800582	Wiper Seal	1	a
-5				
-6		Screw, Set #8-32 x 3/8"	2	a
-7		Screw, Set #8-32 x .38 C.P.	1	a
-8				
-9	800743	Coupling, Modified	1	a
-10	800596	Plate, Anti-Rotation	1	a
-11		Screw, #6-32 x 1/2" P. H.	2	a
-12	800606	Plate, Grounding	1	a
-13				
-14	800420	Washer, Wave Spring	1	a
-15	800421	Pre-Load Washer	1	a
-16	800585	Pivot Post	1	a
-17		Pin, 1/8" Diameter x 1/2" Roll	1	a
-18		Screw, 5/16-24 x 1" F. H. Cap	1	a
-19				
-20				
-21	800620	Magnetic Conductor	2	a
-22	800581	Retainer, Seal	1	a
-23	800425	Flex Steel Grip	1	a
-24		Nut, 6-32 x 5/16 Hex	2	a
-25		Screw, 1/4-20 x 1/2 SHCS	3	b
-26	800350	Pivot, Stem	1	b
-27	903124	Bearing, Sleeve, Pivot	2	b
-28	800667	Washer, Belleville Spring	3	b
-29	800668	Plug, 1/2"	1	b
-30		Screw, M2, 5X.45, 8mm, Soc.F.H.	1	b
-31	800661	Pivot, Retainer	1	b
-32	800659	Pivot Head, Anti-Spin	1	b
-33		Screw, 6-32 x 1/4 P.H.	4	a
-34		Hydraulic Sealant	A.R.	a
-35		Screw, 1/4-20 x 5/8" SHCS	1	b
-36	800503	Seal, Pivot Shaft	1	b
-37				
-38				
-39	800767	Mounting Block, Mechanical	1	a

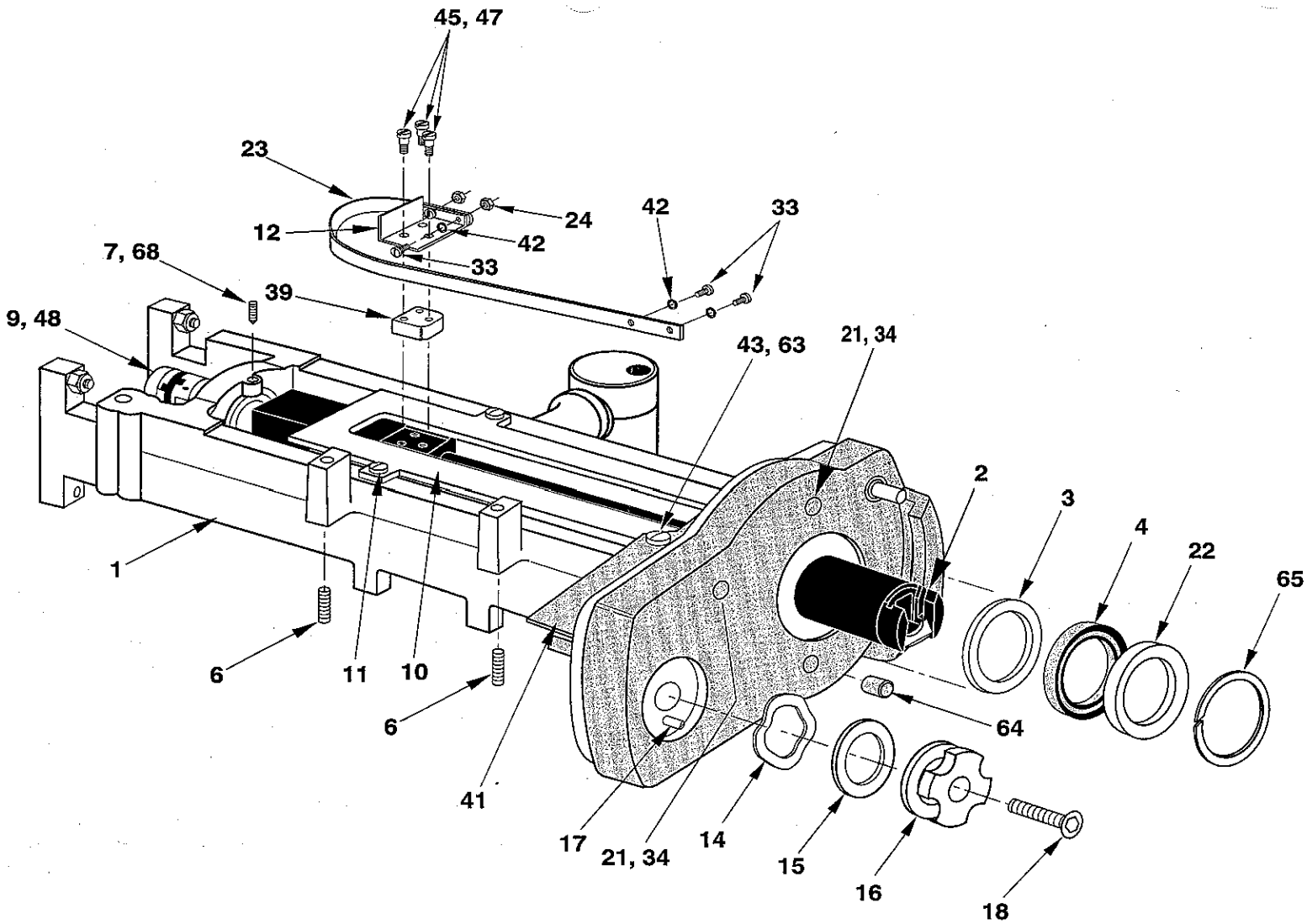

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Fig. 3-2-a Main Frame Assembly (P/N 800741)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
3-2	800741	Main Frame Assembly	Ref.	
-41	800572	PCB Assembly, Hall Effect	1	a
-42		Lockwasher, #6 Internal Tooth	4	a
-43		Lockwasher, #4	1	a
-44		Screw, #8-32 x 1.25" S.H.D.C.	1	b
-45		Shoulder Screw, #6-32, Zinc	3	a
-46				
-47		Loctite, Screw Lock (Purple)	A. R.	a, b
-48		Retaining Compound	A.R.	a
-49	800335	Block, Rear Guide	1	b
-50	800336	Spacer, Pivot	2	b
-51	800340	Bushing, Pivot	1	b
-52	800338	Pin, Locking	1	b
-53		Bushing, Pin	1	b
-54	800729	Bracket, Pin Engagement Assembly	1	b
-55	800344	Bracket, Pin Retaining	1	b
-56	251478	Spring	1	b
-57		Screw, #6-32 Truss Head	2	b
-58				
-59		Washer, #6 x .010	5	b
-60				
-61	219661	Clip, Retainer	3	b
-62		Screw, #6-32 x 5/16"	1	b
-63		Screw, 4-40 x .38	1	a
-64	800431	1/4 x 3/8" Pin	1	a
-65	800352	Snap Ring, Retaining	1	a
-66	800351	Bracket, Granding	1	b
-67	904194	18 mm Retaining Ring	1	b
-68		Loctite, 242, Blue	A.R.	a

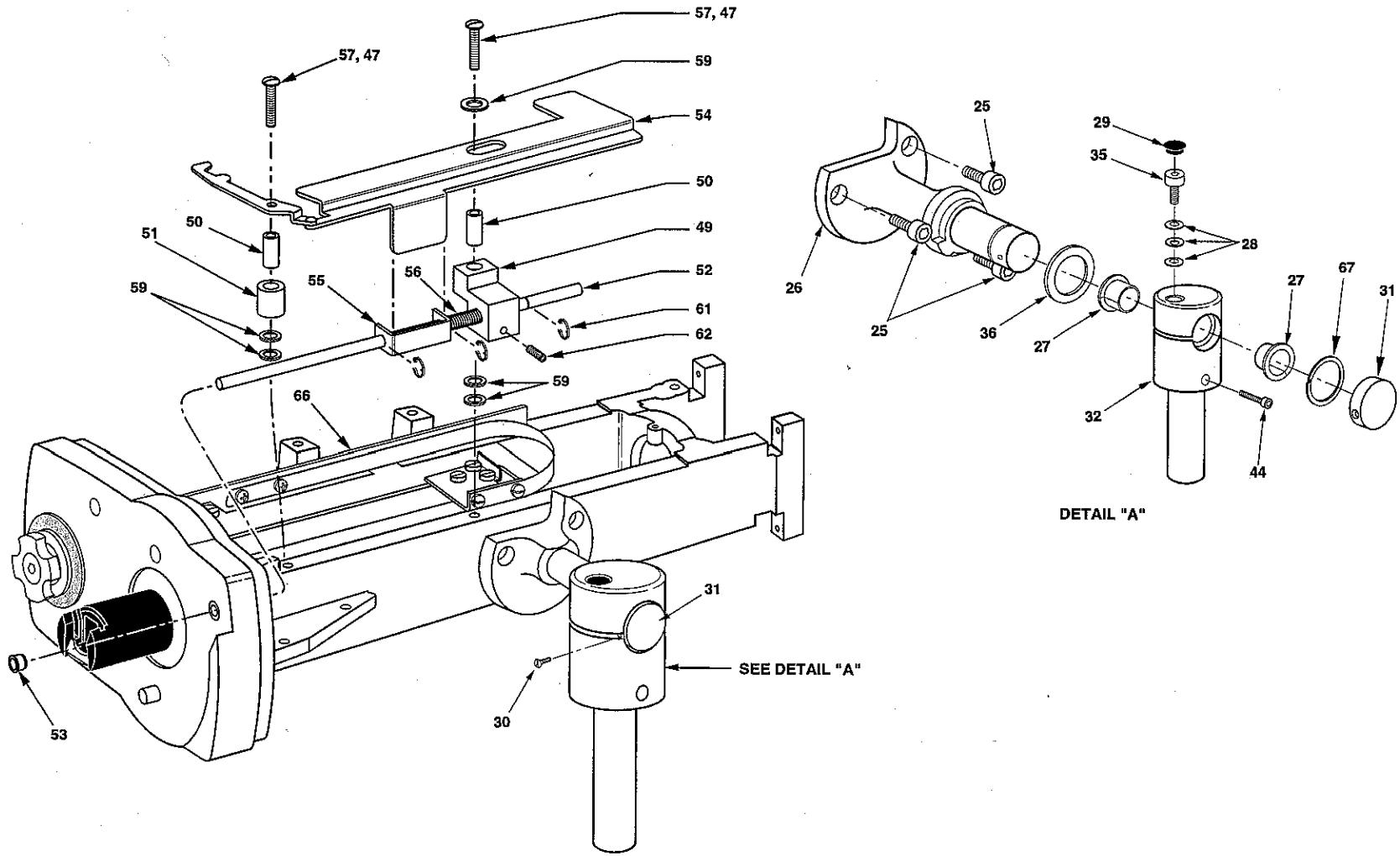

Fig. 3-2-b Main Frame Assembly (P/N 800741)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
3-3	800768	Ram Assembly	Ref.	
-1	800578	Ram	1	
-2	800766	Ball Screw Assembly	1	
-3	800283	Gripper Assembly	1	
-4	800624	Pin, Dowel .094 Dia.	1	
-5	800579	Bracket, Actuator	1	
-6		Screw, #6-32 x 1/4" P. H.	2	
-7		Loctite, Screwlock	A.R.	
-8	600661	Rubber Ball	1	
-9				
-10				
-11		Slick 50 One Grease	A.R.	
-12	800387	Ball Bearing	1	
-13	600391	Bearing Nut	1	

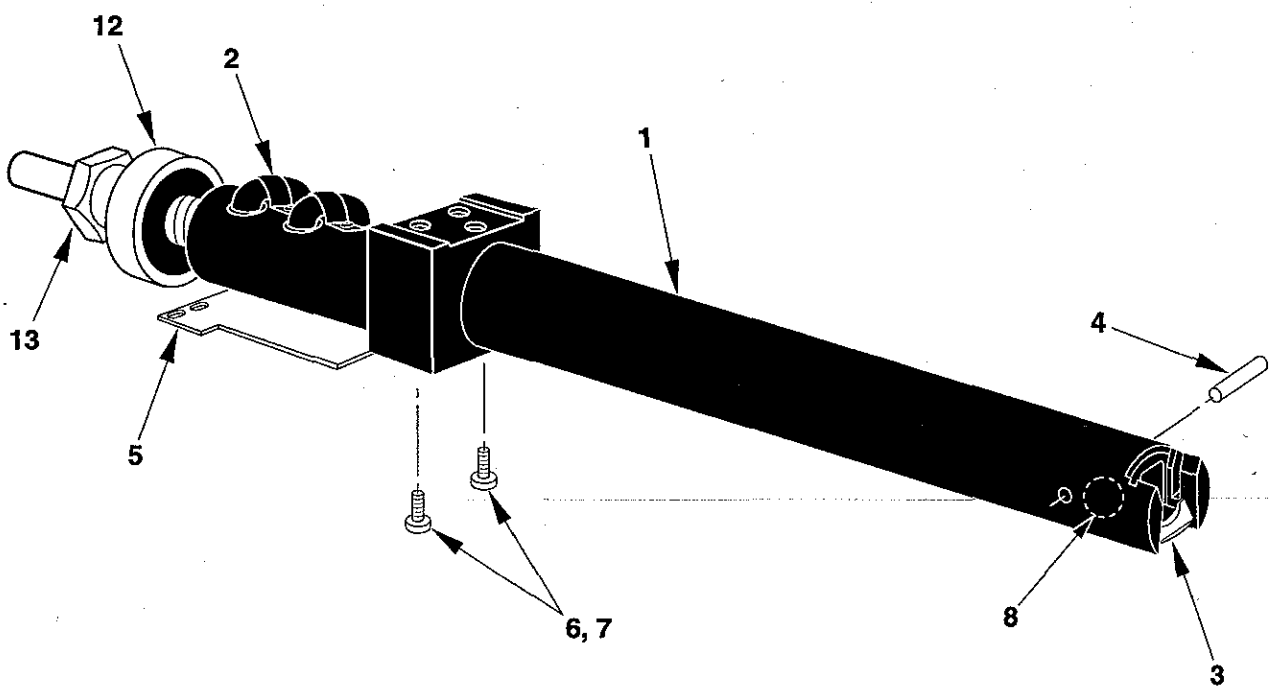

Fig. 3-3 Ram Assembly (P/N 800768)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
3-4	800739	End Cap Assembly	1	
-1	800751	End Cap, Finished	1	
-2	800419	Stud, #8-32 x 2 3/4"	4	
-3	800754	Lamp Assembly, Incandescent, White	1	
-4	800755	Lamp Assembly, Incandescent, Green	1	
-5	540E0024	Lamp, Replacement	2	
-6	800756	Base, Panal Mount Lamp	2	
-7	800758	Cable Assy, Ligfht & Enclder	1	
-8	800479	Label, Power Head Injector Light	1	
-9	800480	Label, Power Head Enable Light	1	
-10		Loctite, Screw Lock	1	

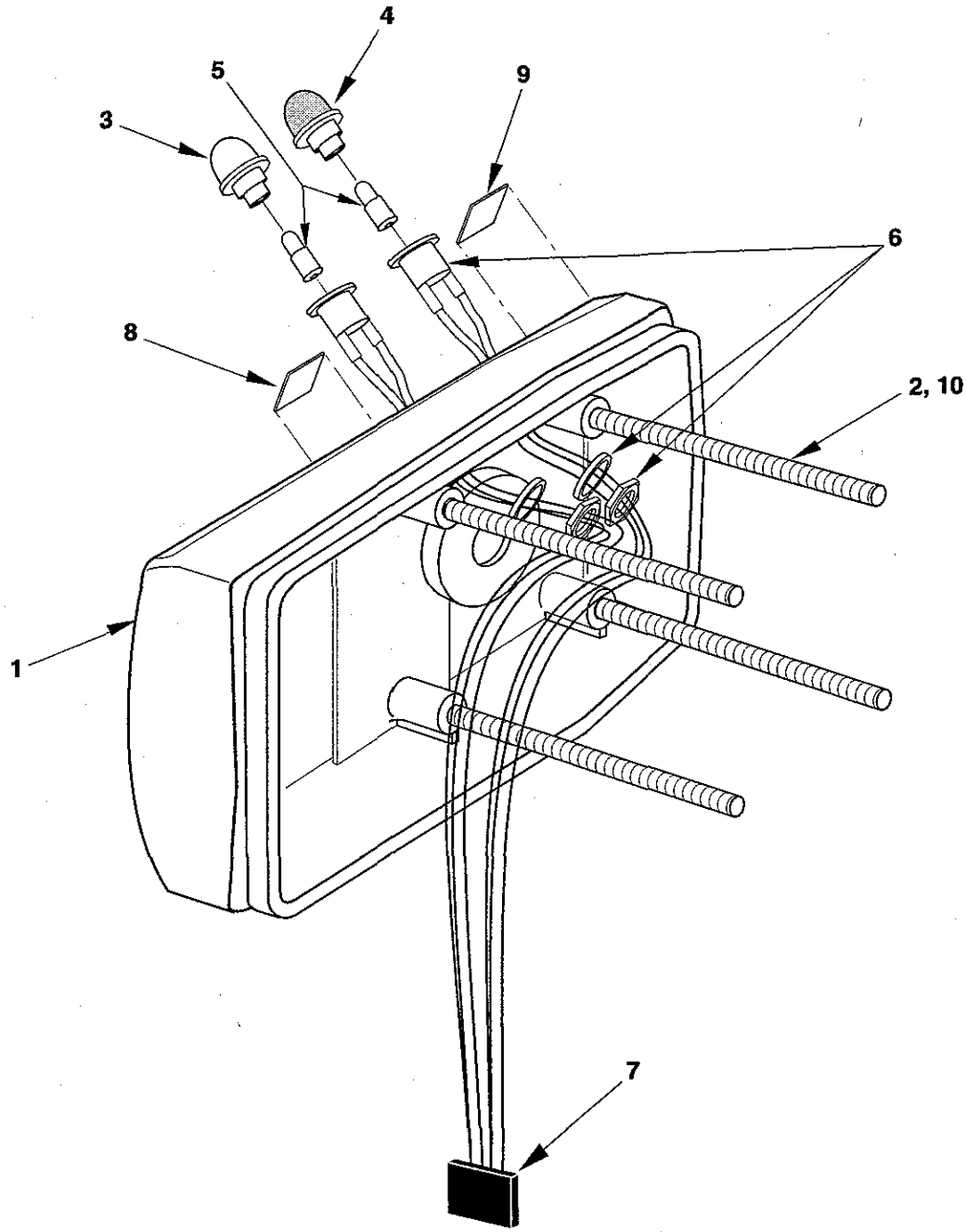

Fig. 3-4 End Cap Assembly (P/N 800739)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
3-5	800742	Motor & Encoder Assembly	Ref.	
-1		Motor, Gearbox & Encoder	1	
-2		Connector, 2 pos. MTE	1	

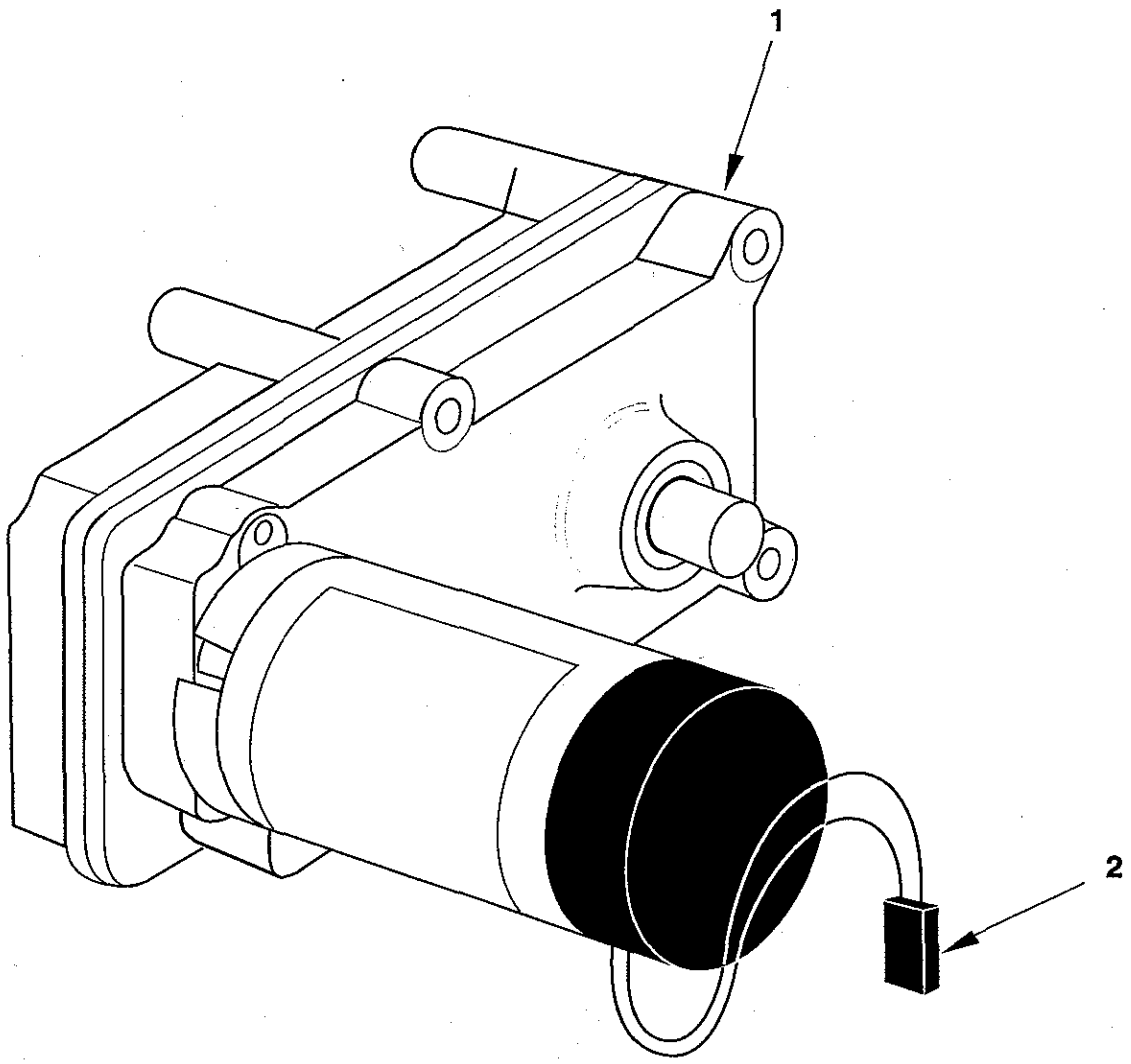

Fig. 3-5 Motor & Encoder Assembly (P/N 800742)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
3-6	800562	PCB Assembly, Powerhead, Manual Knob	Ref.	
-1		Drill Drawing, Power Head P.C.B.	1	
-2				
-3		Opto-Interupter	2	INT1,2
-4				
-5				
-6				
-7		Filter, EMI Suppresion	8	FL2-9
-8		Filter, EMI Suppresion	1	FL1
-9				
-10		IC, Microcomputer, Programmed	1	U1
-11				
-12		Dual J-K Flip-Flop	1	U4
-13		IC, Quad Differential Line DR	1	U3
-14		IC, 3486, Quad Line Receiver	1	U5
-15		IC, Undervoltage, Sensing Circ	1	U6
-16		IC, Transistor Array	1	U2
-17				
-18		Relay, 12V	1	K1
-19		Relay, 12V-SPDT	1	K2
-20		Diode, Light Emitting	6	LED1-6
-21				
-22		Crystal, 4.91520 Mhz	1	CX1
-23				
-24		Capacitor, 22MFD,16V	1	C1
-25		Capacitor, 47µf, 50V AL Elect.	2	C3,6
-26		Capacitor, 100µf, 20V	1	C17
-27		Capacitor, .1µf, 50V	13	C2,5,9-16, 18,19
-28				
-29		Capacitor, 27pf, 1KVDC	2	C7,8
-30		Capacitor, 2.2µf, 25VDC	1	C4
-31				
-32				
-33		Diode, 3 AMP 400V 1N5418	1	D2
-34		Diode	1	D3
-35		Diode-Surmetic-1N4004	1	D1
-36		Diode	1	D4
-37		Resistor, FC 5% 4.7K 1/4W	1	R7
-38		Resistor, 390ý 1/4W, 5%	3	R5,6
-39		Resistor, FC 5% 100ý 1/4W	1	R26
-40		Resistor, FC 5% 10 MEG 1/4W	1	R8
-41		Resistor, FC 5% 10K 1/4W	2	R10,12
-42		Resistor	3	R23-25
-43		Resistor, 220ý 1/4W	1	R27
-44				

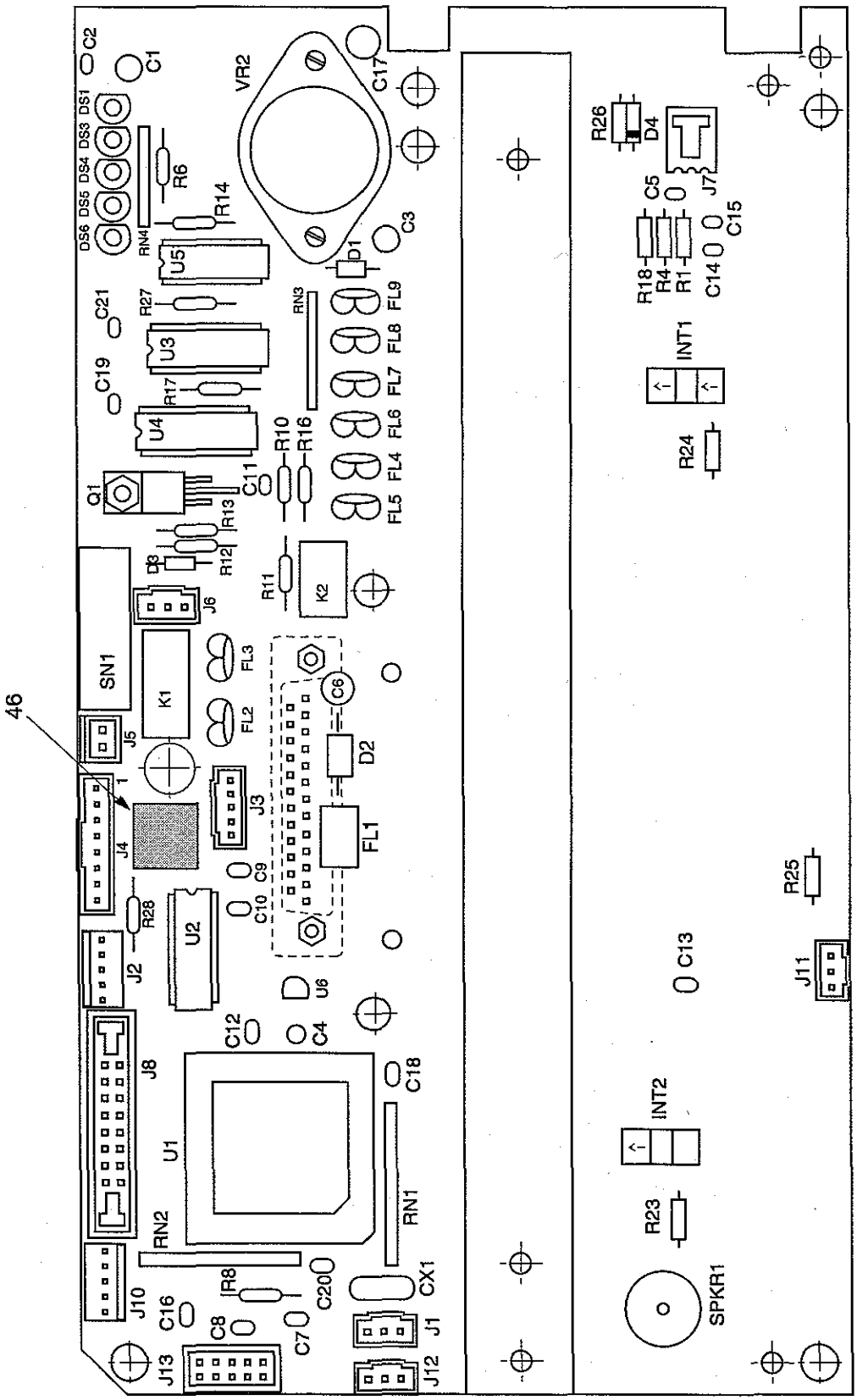

Fig. 3-6 PCB Ass'y, Powerhead, Manual Knob (P/N 800562)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
3-6	800562	PCB Assembly, Powerhead, Manual Knob	Ref.	
-45		Resistor, 10ý 1/4W	2	R16,17
-46		PVC Bumper	1	
-47		Resistor, 100ý Y4W-1%	1	R1
-48		Resistor, Precision 1%, 1/4W	1	R18
-49		Resistor, 4.64K	1	R4
-50				
-51				
-52				
-53		Resistor, FC 5% 1/4W-470	1	R11
-54				
-55				
-56		Resistor Network, 390ý 4 Devices	1	RN4
-57		Resistor Network, 10ý 9 Devices	1	RN3
-58				
-59		Resistor Network, 4.7K	1	RN1,RN2
-60				
-61				
-62				
-63		Connector, Single Row 2 Pin	1	J5
-64		Connector, Single Row 4 Pin	2	J3,J6
-65		Connector, Single Row 8 Pin	1	J4
-66				
-67		Right Angle Header-3 Position	1	J7
-68		Plug, 25 Pin D-Shell	1	J9
-69				
-70		IC Regulator 5 Volt-3 Amp	1	VR2
-71				
-72				
-73		Filter-R-C Snubber Network	1	SN1
-74		Transistor, 2N6041	1	Q1
-75				
-76				
-77				
-78				
-79		Screw, #4-40 x 5/16" P. H.	3	
-80		Washer, #4 Internal Tooth	3	
-81		Nut, Hex #4-40 x 1/4	3	
-82				
-83		Socket, 68 Pin PLCC, Thru Ho	1	
-84				
-85		Jackscrew, Female, Long	2	J9
-86		Connector-10 Pos-Ribbon	1	J13
-87		Ribbon Header, Straight 16 Pin	1	J8
-88		Audio Transducer	1	Spkr 1

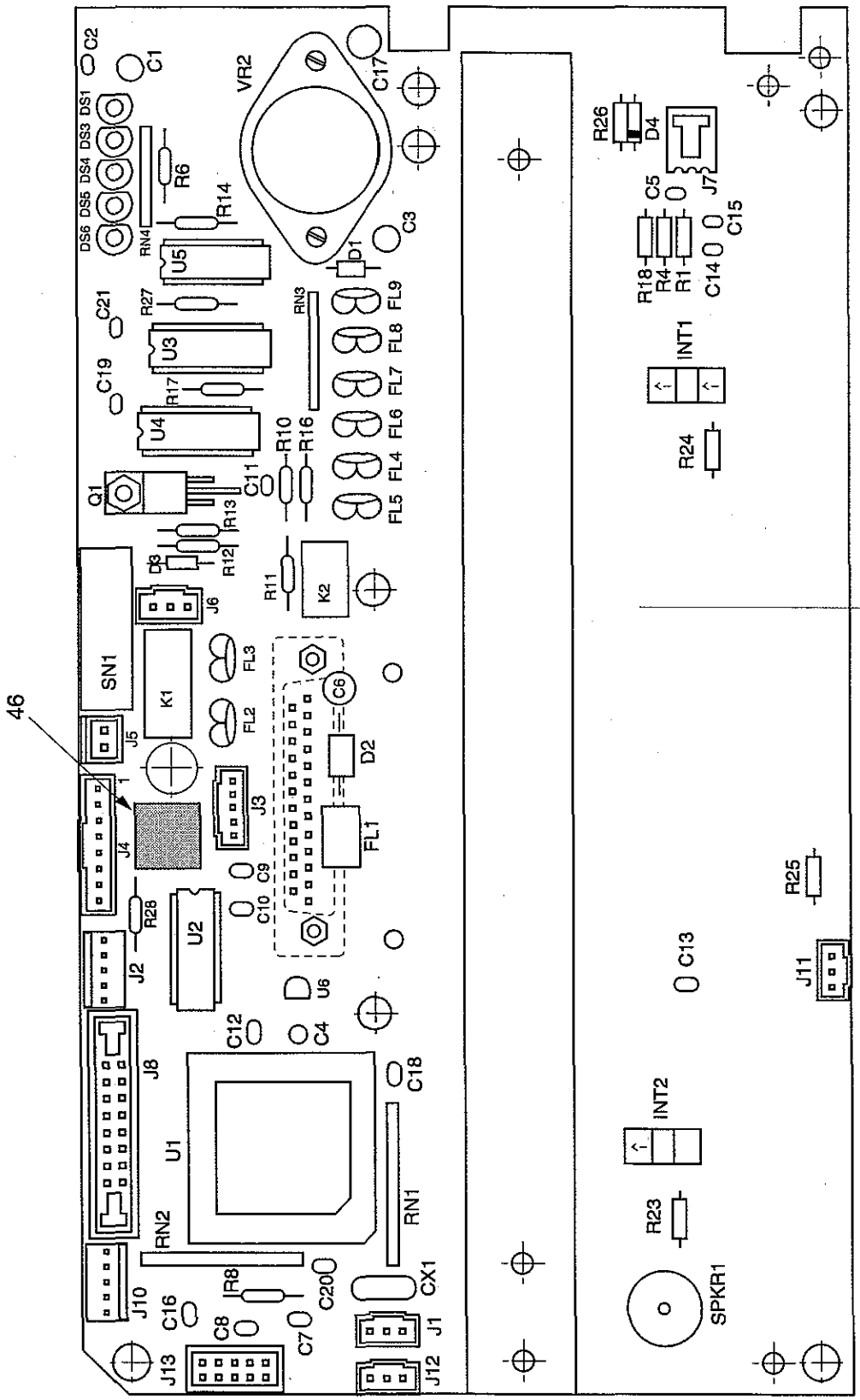

Fig. 3-6 PCB Ass'y, Powerhead, Manual Knob (P/N 800562)

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SECTION IIIB
POWERHEAD ASSEMBLY

OLD STYLE (SWITCH KNOB)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
3-1	800630	Power Head Assembly	Ref.	
-1	800631	Main Frame Assembly (See Fig. 3-2A, 3-2B)	1	
-2	800692	Bracket, Keyboard Assembly	1	
-3	800267	End Cap Assembly (See Fig. 3-4)	1	
-4	800632	Motor and Encoder Assembly (See Fig. 3-5)	1	
-5	800924	Harness Assembly, Motor Encoder	1	
-6	800313	Top Cover, Finished	1	
-7	800408	Bottom Cover Assembly	1	
-8	800567	Keyboard	1	
-9	800409	Connector Plate Assembly	1	
-10		Screw, #2-56 x .25" Soc. Hd. Cap	2	
-11		Washer, #8 Rubber	8	
-12		Spacer, #8 Clearance x 1/4"	2	
-13		Washer, #2 Lock	2	
-14	903085	Pot Assembly, Slide	1	
-15		Screw, #2-56 x .312" P. H.	2	
-16	800562	PCB Assembly, Powerhead (See Fig. 3-7)	1	
-17		Nut, #2-56 Hex	2	
-18		Screw, #8-32 x 1 3/4" Phillips P.H.	3	
-19		Screw, #6-32 x 1/4" P. H.	2	
-20		Screw, #6-32 x 5/8" F. H.	2	
-21		Gasket Material	A.R.	
-22		Nut, Nylok, #8-32 Hex	4	
-23		Part & Serial Number Plate	1	
-24		Washer, Brass	4	
-25		Label, IEC Risk Class	1	
-26		Screw SHCS #8-32 x 1.37	3	
-27		Washer, Ext Tooth Lock	4	
-28	800568	P.C.B. Assembly, Display Powerhead	1	
-29	600694	Cable, Ribbon 10 Pin	1	
-30	249937	Cable, Ribbon 16 Pin	1	
-31		Lockwasher, #6 Internal Tooth	2	
-32		Screw, Pan Head #6-32 x 3/8"	2	
-34	800396	Modified coupling	1	
-35		Retaining compound	A.R.	

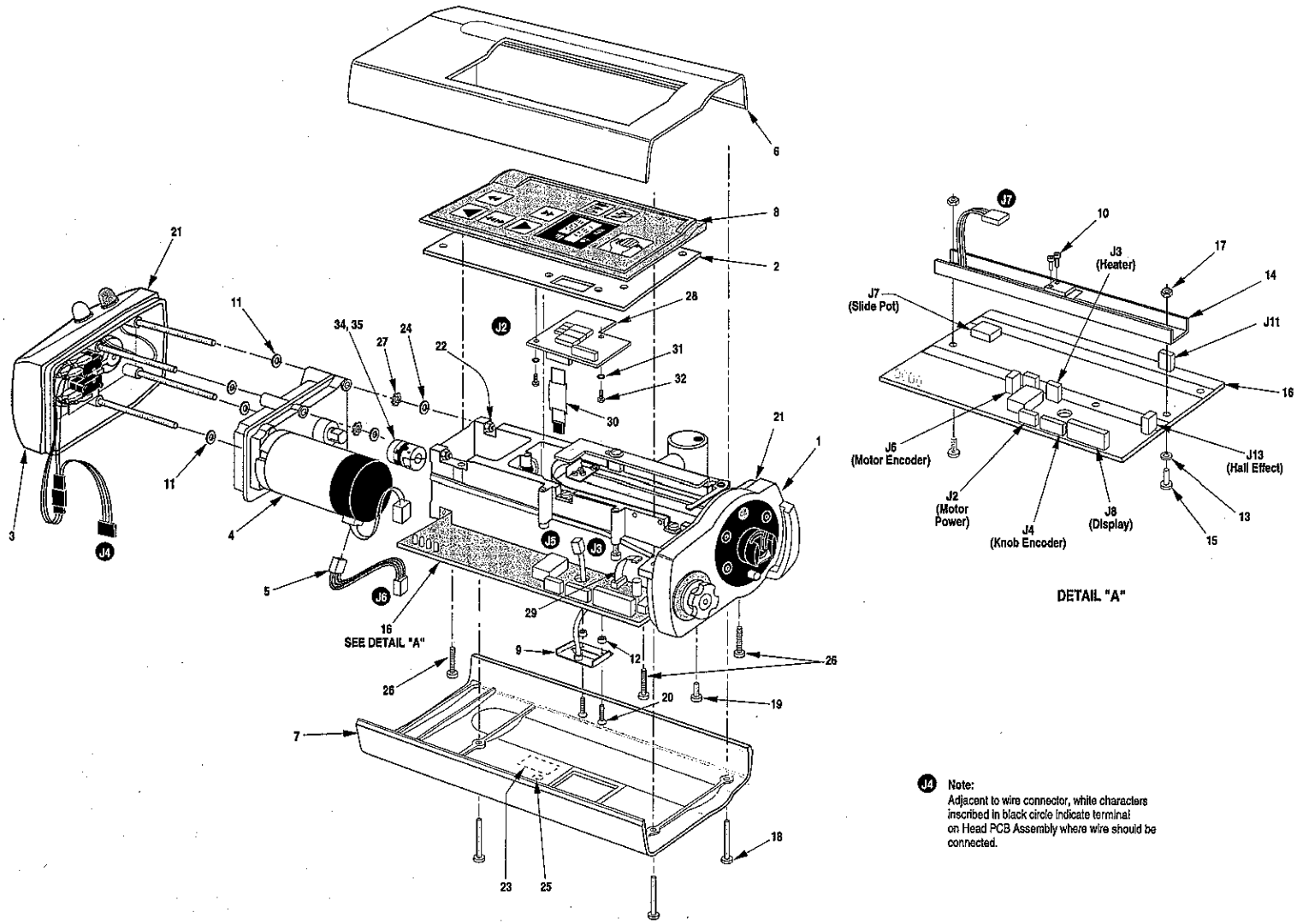

Fig. 3-1 Powerhead Assembly (P/N 800630)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
3-2	800631	Main Frame Assembly	Ref.	
-1	800629	Main Frame (Finished)	1	a
-2	800633	Ram Assembly (See Fig. 3-3)	1	a
-3	800580	Bushing	1	a
-4	800582	Wiper Seal	1	a
-5				
-6		Screw, Set #8-32 x 3/8"	2	a
-7		Screw, Set #8-32 x .38 C.P.	1	
-8				
-9	800396	Coupling Modified	1	a
-10	800596	Plate, Anti-Rotation	1	a
-11		Screw, #6-32 x 3/8" P. H.	2	a
-12	800606	Plate, Grounding	1	a
-13	800414	O-Ring, Plate Seal	1	a
-14	800420	Washer, Wave Spring	1	a
-15	800421	Pre-Load Washer	1	a
-16	800585	Pivot Post	1	a
-17		Pin, 1/8" Diameter x 1/2" Roll	1	a
-18		Screw, 5/16-24 x 1" F. H. Cap	1	a
-19	800634	Syringe Plate Assembly	1	a
-20		Screw, 5/16-24 x 1/2" Phillips F. H., St. Stl.	4	a
-21	800620	Magnetic Conductor	1	a
-22	800581	Retainer, Seal	1	a
-23	800425	Flex Steel Grip	1	a
-24		Nut, 6-32 x 5/16 Hex	2	a
-25		Screw, 1/4-20 x 5/8 SHCS	3	b
-26	800660	Pivot, Stem	1	b
-27	903124	Bearing, Sleeve, Pivot	2	b
-28		Washer, Belleville Spring	3	b
-29	800668	Plug, 1/2"	1	b
-30		Screw, M2, 5X.45, 8mm, P.R.F.H.	1	b
-31	800661	Pivot, Retainer	1	b
-32	800659	Pivot Head, Anti-Spin	1	b
-33		Screw, 6-32 x 1/4 P.H.	4	a
-34		Hydraulic Sealant	A.R.	a
-35		Screw, 1/4-20 x 1/2" SHCS	1	b
-36	800503	Seal, Pivot Shaft	2	b
-37				
-38				
-39	800418	Mounting Block,	1	a
-40		Washer, #6, Steel	2	a

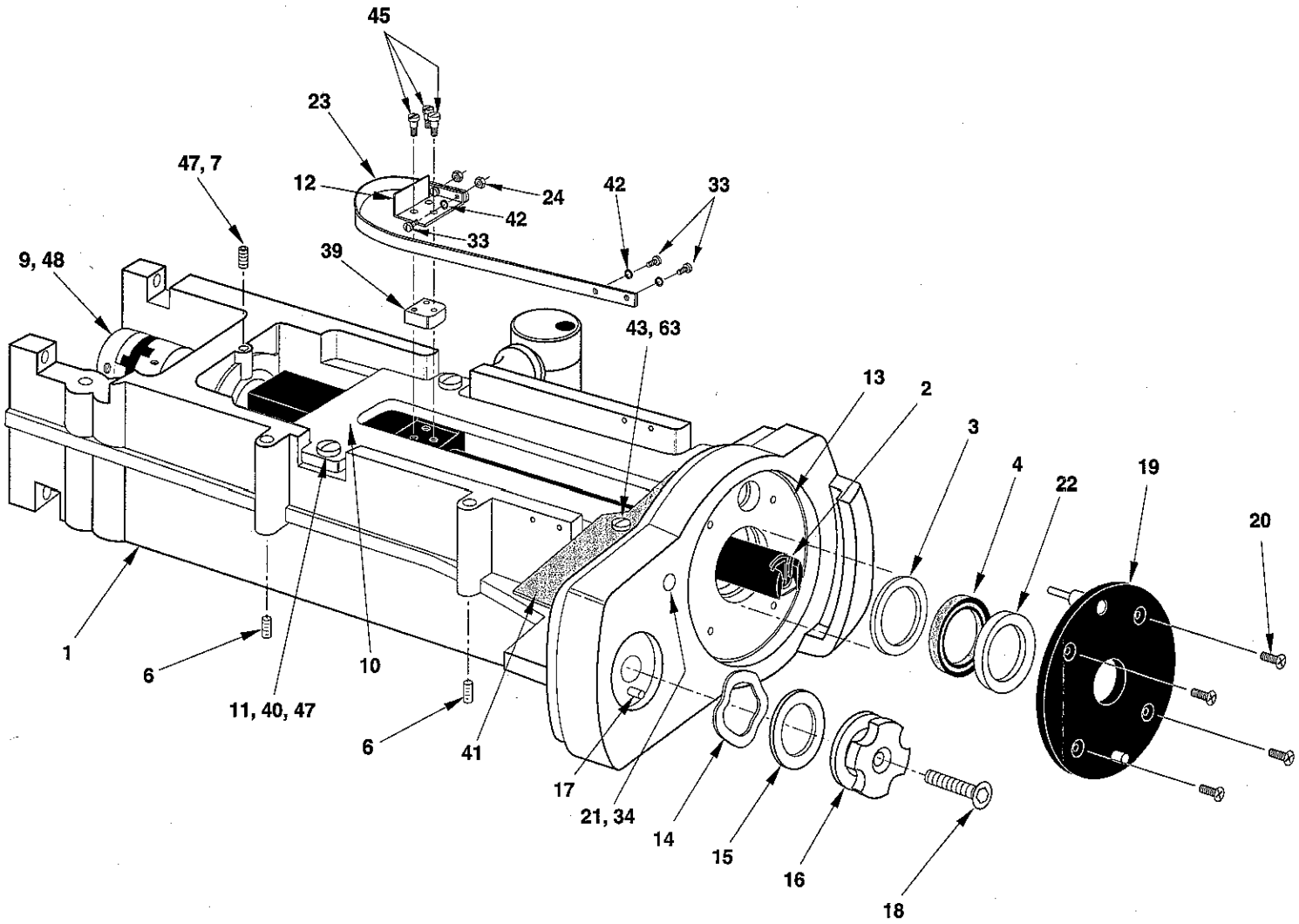

Fig. 3-2-a Main Frame Assembly (P/N 800631)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
3-2	800631	Main Frame Assembly	Ref.	
-41	800572	PCB Assembly, Hall Effect	1	a
-42		Lockwasher, #6 Internal Tooth	4	a
-43		Lockwasher, #4	1	a
-44		Screw, #8-32 x 1.25" S.H.D.C.	1	b
-45		Shoulder Screw, #6-32, Zinc	3	a
-46				
-47		Loctite, Screw Lock (Purple)	A. R.	a, b
-48		Retaining Compound	A. R.	a
-49	800335	Block, Rear Guide	1	b
-50	800336	Spacer, Pivot	2	b
-51	800337	Bushing, Pivot	1	b
-52	800338	Pin, Locking	1	b
-53	800340	Bushing, Pin	1	b
-54	800729	Bracket, Pin Engagement Assembly	1	b
-55	800344	Bracket, Pin Retaining	1	b
-56	251478	Spring	1	b
-57		Screw, #6-32 Truss Head	2	b
-58				
-59		Washer, #6 x .010	5	b
-60				
-61	219661	Clip, Retainer	3	b
-62		Screw, #6-32 x 5/16"	1	b
-63		Screw, 4-40 x .38	1	a

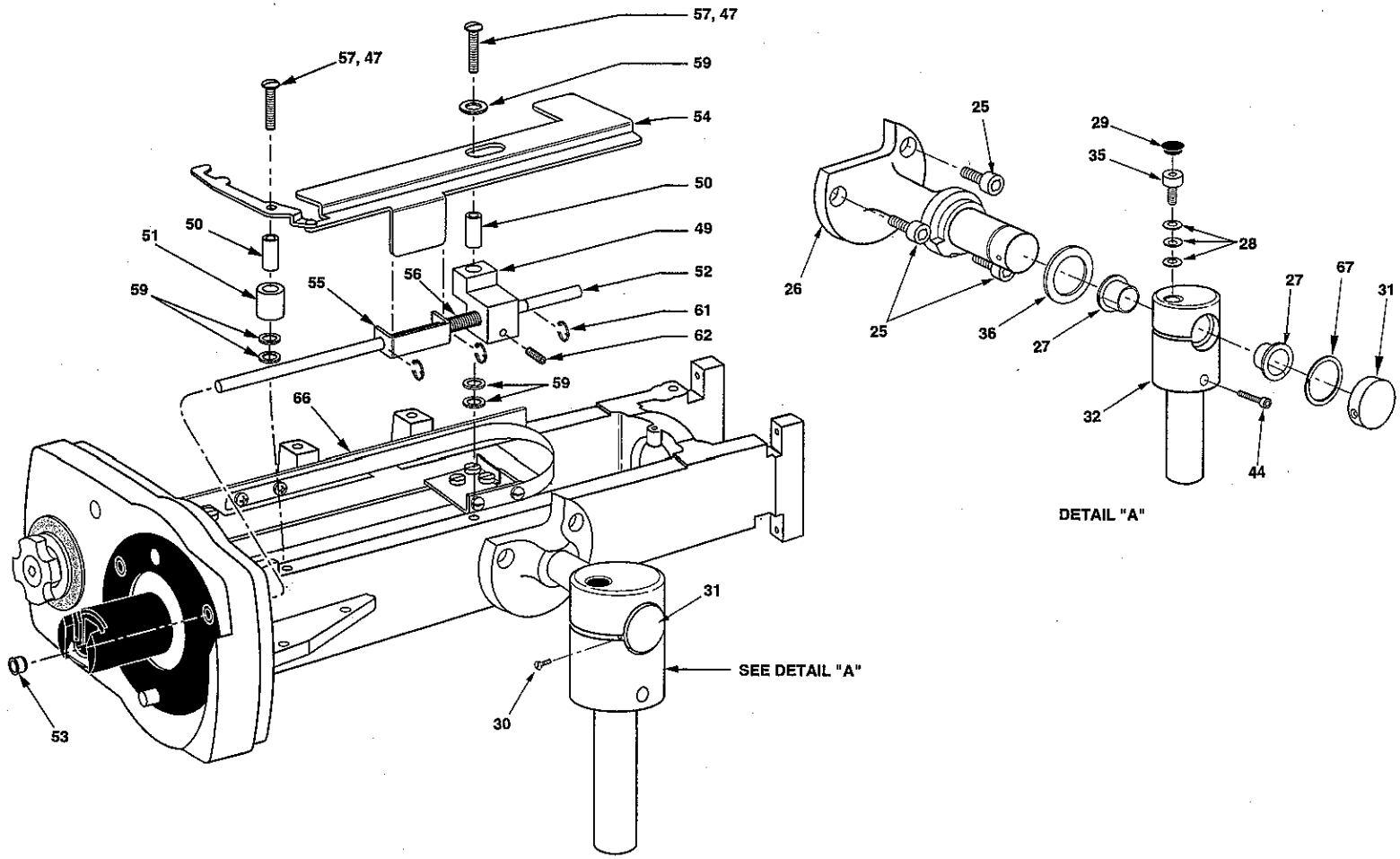

Fig. 3-2-b Main Frame Assembly (P/N 800631)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
3-3	800633	Ram Assembly	Ref.	
-1	800578	Ram	1	
-2	800577	Ball Screw Assembly	1	
-3	800283	Gripper Assembly	1	
-4	800624	Pin, Dowel .094 Dia.	1	
-5	800579	Bracket, Actuator	1	
-6		Screw, #6-32 x 1/4" P. H.	2	
-7		Loctite, Screwlock	A.R.	
-8	600661	Rubber Ball	1	
-9				
-10				
-11		Slick 50 One Grease	A.R.	
-12	800387	Ball Bearing	1	
-13	600391	Bearing Nut	1	

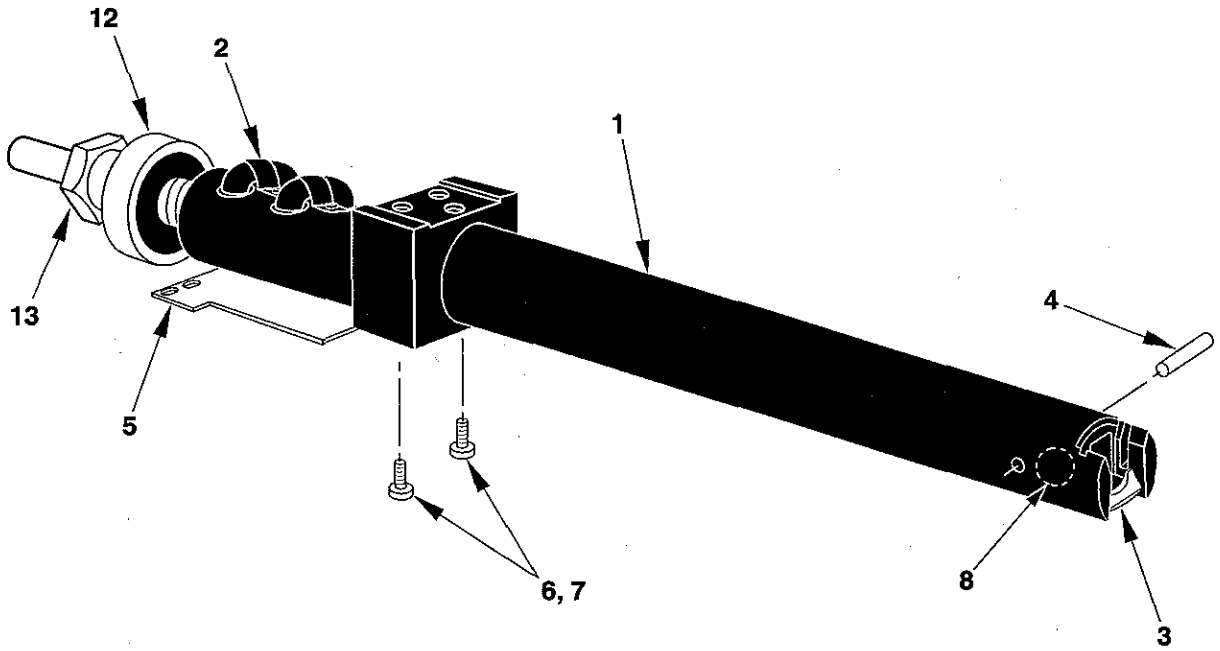

Fig. 3-3 Ram Assembly (P/N 800633)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
3-4	800267	End Cap Assembly	1	
-1	800312	End Cap, Finished	1	
-2		Stud, #8-32 x 2 3/4"	4	
-3	540E0021	Lamp, Assembly, Incadescent, Clear	1	
-4	540E0022	Lamp Assembly, Incadescent, Green	1	
-5	800385	Knob, Encoder	1	
-6	800263	Rotary Actuator	1	
-7	800264	Shaft	1	
-8		Set Screw #6-32 x .31	2	
-9	804E0074	Switch, Miniature	4	
-10	800265	Bushing W/Nut, Panel	1	
-11		Lockwasher	1	
-12	800266	Switch Plate	1	
-13	800947	Cable Assy, Microswitch	1	
-14	800925	Cable Assy, Light & Encorder	1	
-15		Screw #4-40 x 1.00	4	
-16		Lock Washer #4 INT. Tooth	4	
-17	800479	Label, Power Head Injector Light	1	
-18	800480	Label, Power Head Enable Light	1	
-19		Loctite, Screw Lock	A. R.	
-20				
-21				
-22		Lockwasher	4	
-23	544E0024	Bulb	2	

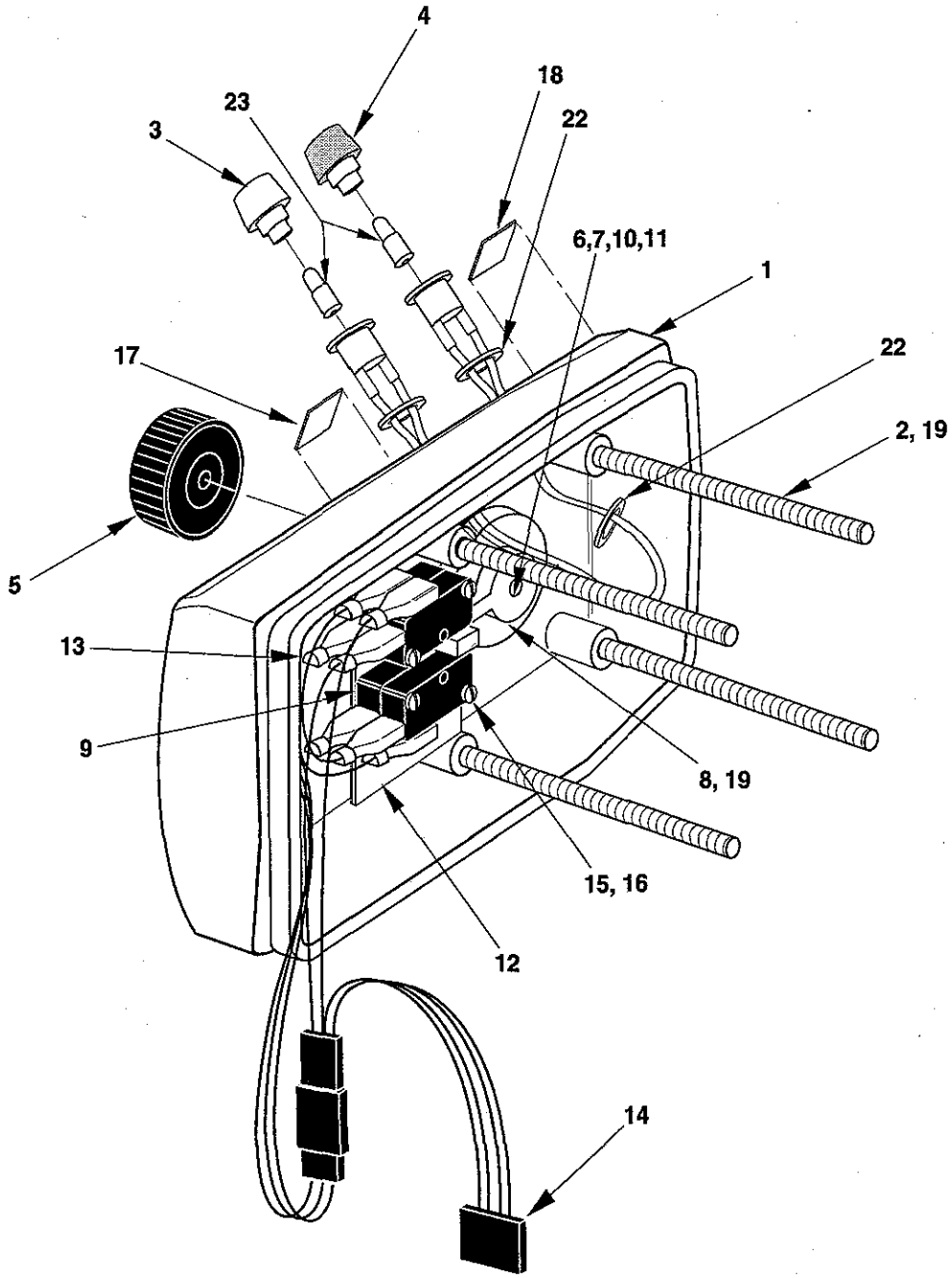

Fig. 3-4 End Cap Assembly (P/N 800267)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
3-5	800632	Motor & Encoder Assembly	Ref.	
-1		Motor, Gearbox & Encoder	1	
-2		Connector, 2 pos. MTE	1	

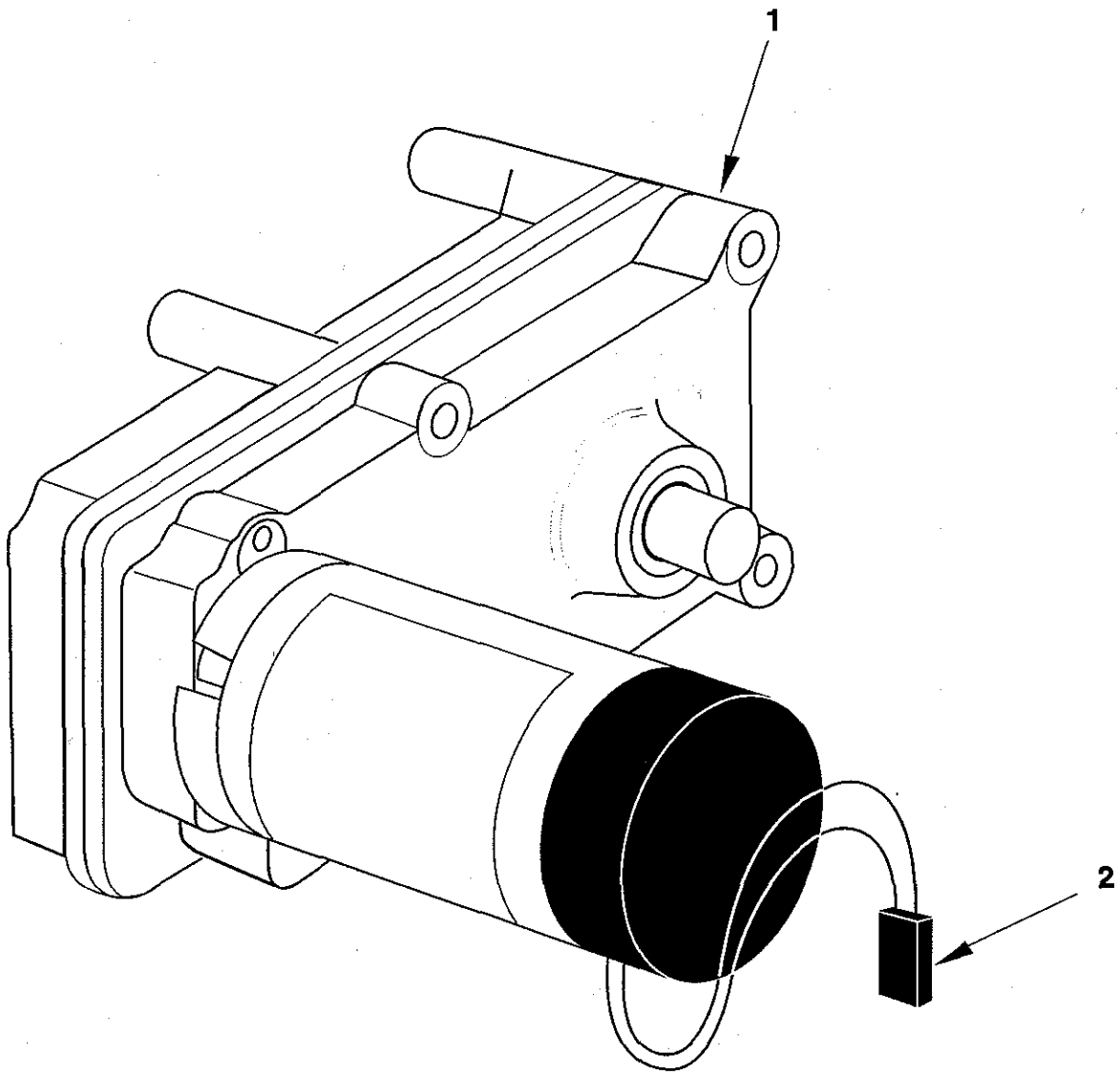

Fig. 3-5 Motor & Encoder Assembly (P/N 800632)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
3-6	800562	PCB Assembly, Powerhead, Manual Knob	Ref.	
-1		Drill Drawing, Power Head P.C.B.	1	
-2				
-3		Opto-Interupter	2	INT1,2
-4				
-5				
-6				
-7		Filter, EMI Suppresion	8	FL2-9
-8		Filter, EMI Suppresion	1	FL1
-9				
-10		IC, Microcomputer, Programmed	1	U1
-11				
-12		Dual J-K Flip-Flop	1	U4
-13		IC, Quad Differential Line DR	1	U3
-14		IC, 3486, Quad Line Receiver	1	U5
-15		IC, Undervoltage, Sensing Circ	1	U6
-16		IC, Transistor Array	1	U2
-17				
-18		Relay, 12V	1	K1
-19		Relay, 12V-SPDT	1	K2
-20		Diode, Light Emitting	6	LED1-6
-21				
-22		Crystal, 4.91520 Mhz	1	CX1
-23				
-24		Capacitor, 22MFD,16V	1	C1
-25		Capacitor, 47µf, 50V AL Elect.	2	C3,6
-26		Capacitor, 100µf, 20V	1	C17
-27		Capacitor, .1µf, 50V	13	C2,5,9-16, 18,19
-28				
-29		Capacitor, 27pf, 1KVDC	2	C7,8
-30		Capacitor, 2.2µf, 25VDC	1	C4
-31				
-32				
-33		Diode, 3 AMP 400V 1N5418	1	D2
-34		Diode	1	D3
-35		Diode-Surmetic-1N4004	1	D1
-36		Diode	1	D4
-37		Resistor, FC 5% 4.7K 1/4W	1	R7
-38		Resistor, 390ý 1/4W, 5%	3	R5,6
-39		Resistor, FC 5% 100ý 1/4W	1	R26
-40		Resistor, FC 5% 10 MEG 1/4W	1	R8
-41		Resistor, FC 5% 10K 1/4W	2	R10,12
-42		Resistor	3	R23-25
-43		Resistor, 220ý 1/4W	1	R27
-44				

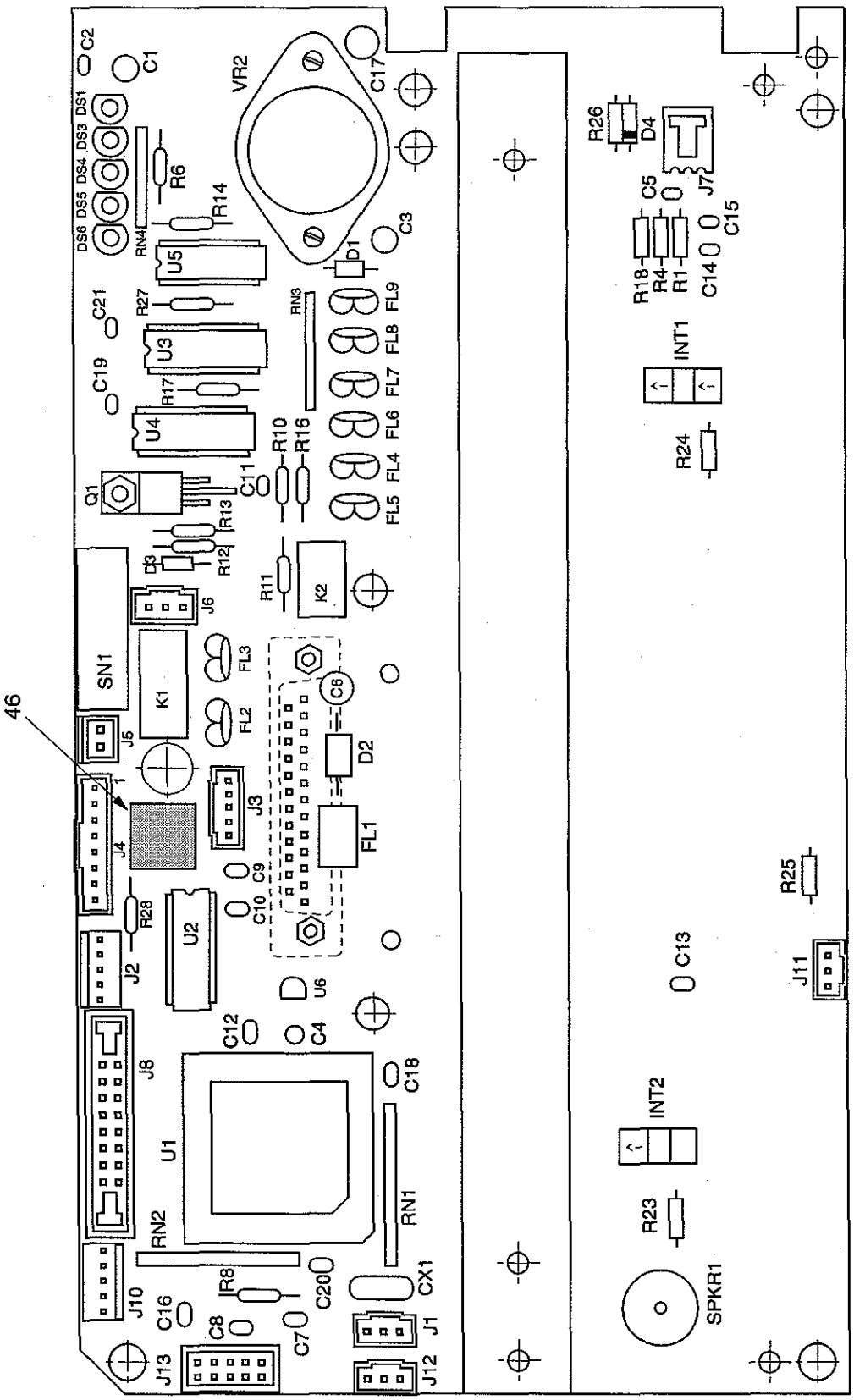

Fig. 3-6 PCB Ass'y, Powerhead, Manual Knob (P/N 800562)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
3-6	800562	PCB Assembly, Powerhead, Manual Knob	Ref.	
-45		Resistor, 10ý 1/4W	2	R16,17
-46		PVC Bumper	1	
-47		Resistor, 100ý Y4W-1%	1	R1
-48		Resistor, Precision 1%, 1/4W	1	R18
-49		Resistor, 4.64K	1	R4
-50				
-51				
-52				
-53		Resistor, FC 5% 1/4W-470	1	R11
-54				
-55				
-56		Resistor Network, 390ý 4 Devices	1	RN4
-57		Resistor Network, 10ý 9 Devices	1	RN3
-58				
-59		Resistor Network, 4.7K	1	RN1,RN2
-60				
-61				
-62				
-63		Connector, Single Row 2 Pin	1	J5
-64		Connector, Single Row 4 Pin	2	J3,J6
-65		Connector, Single Row 8 Pin	1	J4
-66				
-67		Right Angle Header-3 Position	1	J7
-68		Plug, 25 Pin D-Shell	1	J9
-69				
-70		IC Regulator 5 Volt-3 Amp	1	VR2
-71				
-72				
-73		Filter-R-C Snubber Network	1	SN1
-74		Transistor, 2N6041	1	Q1
-75				
-76				
-77				
-78				
-79		Screw, #4-40 x 5/16" P. H.	3	
-80		Washer, #4 Internal Tooth	3	
-81		Nut, Hex #4-40 x 1/4	3	
-82				
-83		Socket, 68 Pin PLCC, Thru Ho	1	
-84				
-85		Jackscrew, Female, Long	2	J9
-86		Connector-10 Pos-Ribbon	1	J13
-87		Ribbon Header, Straight 16 Pin	1	J8
-88		Audio Transducer	1	Spkr 1

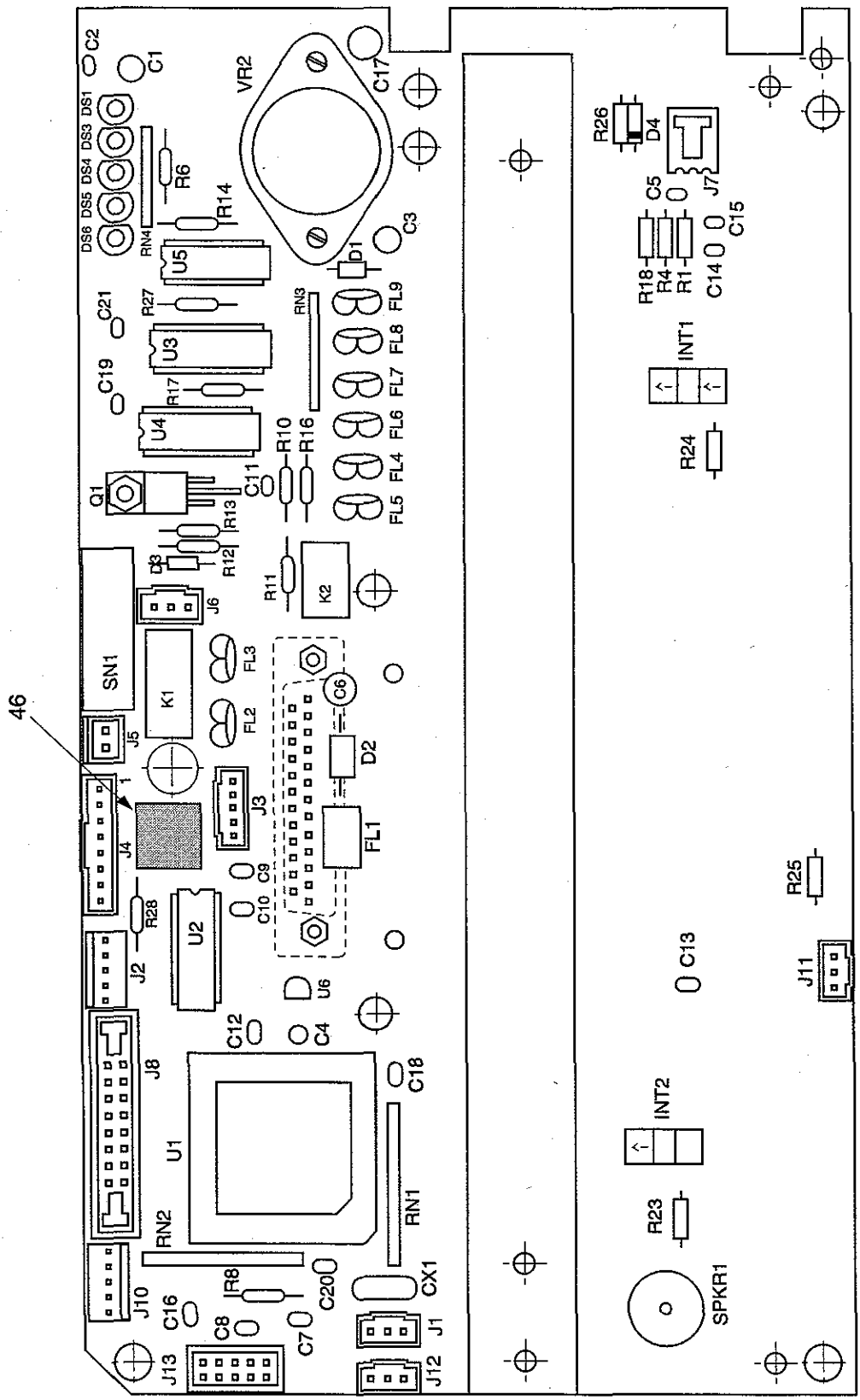

Fig. 3-6 PCB Ass'y, Powerhead, Manual Knob (P/N 800562)

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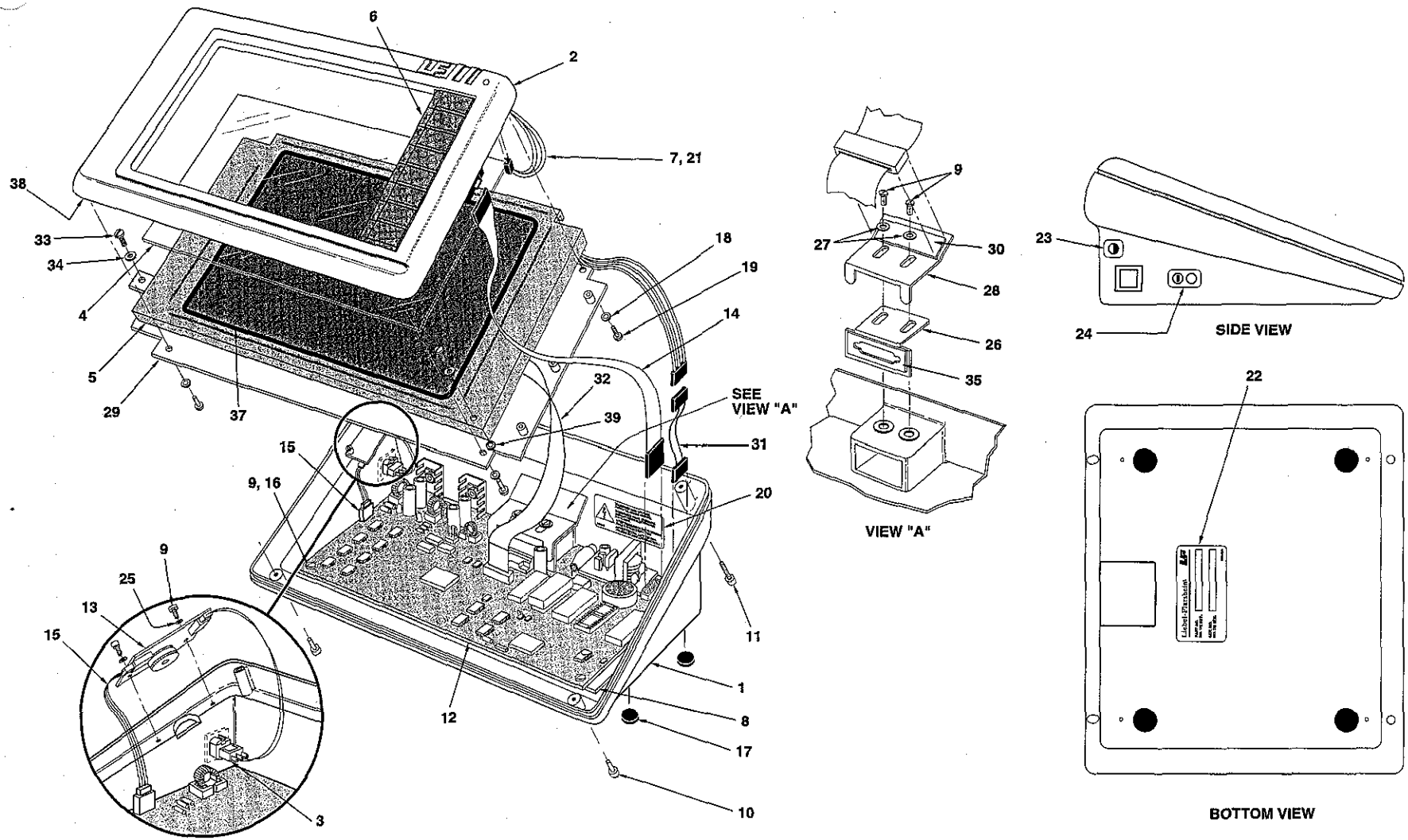
SECTION IV-A
CONSOLE ASSEMBLY

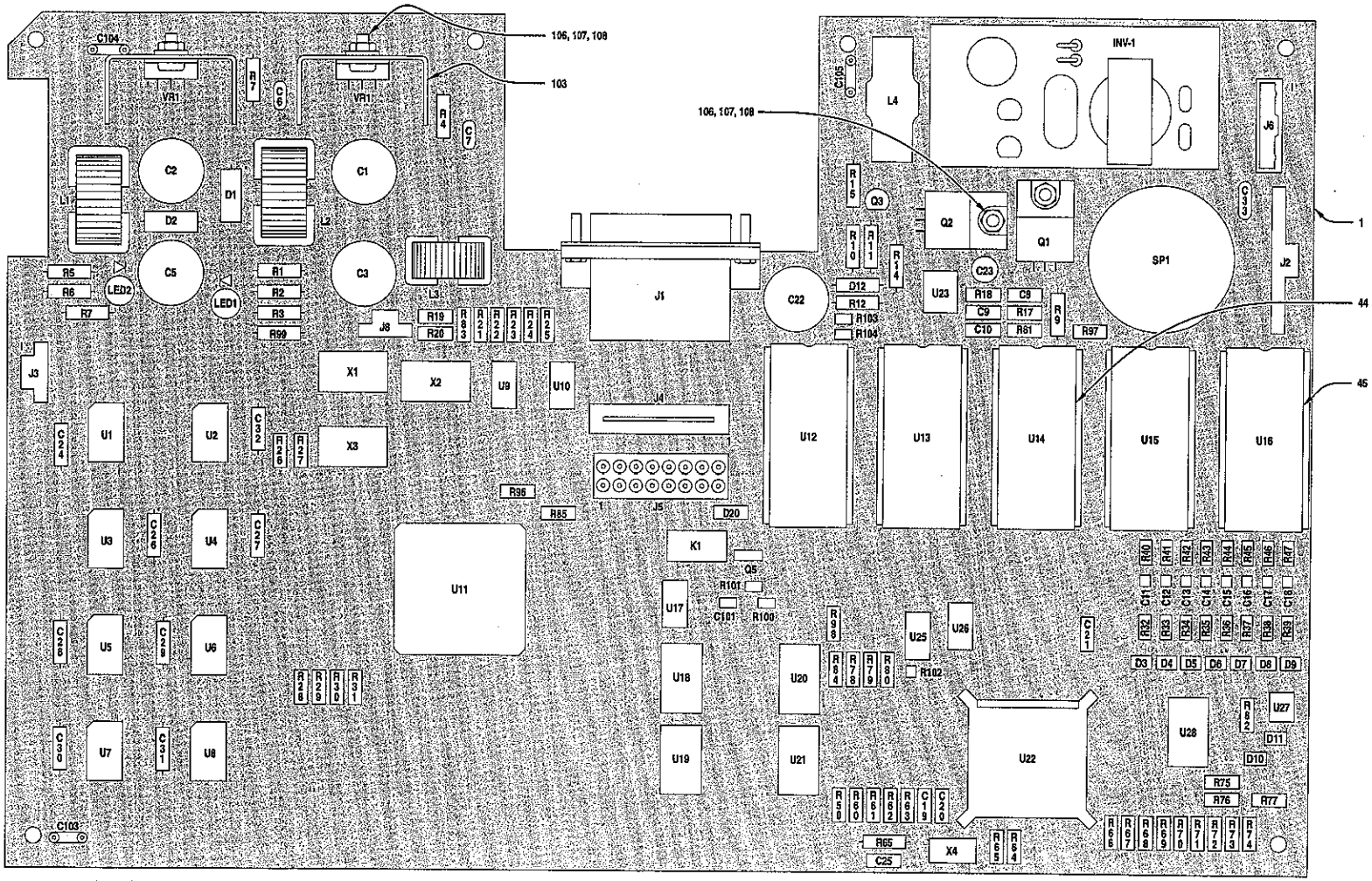
Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
4-1	800017	Console Assembly	Ref.	
-1	800294	Base, Console, Painted	1	
-2	800259	Bezel, Painted	1	
-3	800921	Switch Assembly, On/Off	1	
-4	800268	LCD Lens, Console, Anti-Glare	1	
-5	304E0005	Display, Flat Panel	1	
-6	800946	Key-Board, Console	1	
-7	800926	Power Light Assembly, Console	1	
-8	800405	Insulator, PCB	1	
-9		Screw, #6-32 x 1/4 Pan Head	10	
-10		Screw, #6-32 x 5/8 S.H. Cap	2	
-11		Screw, #6-32 x 1-1/8 S.H. Cap	2	
-12	800888	PCB Assembly, Console	1	
-13	800920	Pot, Thumbwheel Type, 10K	1	
-14	800922	Harness Assembly., Key-Board	1	
-15	800923	Harness Assembly, Pot & On/Off Switch	1	
-16		Washer, #6, Lock Internal Tooth	6	
-17		Foot, Rubber	4	
-18		Washer, #6 Lock	4	
-19		Screw, #6-32 x 5/16 Pan Head	4	
-20		Label, High Voltage Warning	1	
-21		Black Silicon Rubber	A.R.	
-22		Label, Part & Serial Number	1	
-23		Label, Viewing Angle Adjusted	1	
-24		Label, Push On/Off switch	1	
-25		Washer, Fiber #6	2	
-26	800254	Rear Connector Plate	1	
-27		Washer, #6 Flat	2	
-28	800515	Bracket, EMI Connector	1	
-29	800260	Adaptor Plate	1	
-30		Foam Tape	A.R.	
-31	800133	Cable Assy, CCFT	1	
-32	800134	Cable Assy, LCD W/Ferrite Bead	1	
-33		Screw, 4-10 x 1/4, Pan HD.	4	
-34		Washer, Flat, Nylon	4	
-35		Gasket, Console-Rear Conn. PL.	1	
-36		Tape - EMI FOIL	A.R.	
-37		Gasket	A.R.	
-38		Gasket, Conductive Elastomer	39.00"	
-39		Shoulder Washer, #4 Nylon	4	



800961-C Sept 2000

Fig. 4-1-a Console Assembly (P/N 800017)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
4-2	800888	PCB Assembly, Console	Ref.	
-1		PCB Console, Multilayer	1	
-2				
-3		Capacitor, 2200pf 50V	1	C8
-4		Capacitor, .1µf 50V Axial Lead	8	C24,26-32
-5				
-6				
-7		Capacitor, .1µf Ceramic 50V SMT	3	C101, 21,
25				
-8				
-9		Capacitor, 1000pf, 1000V Ceramic	3	C103, C104,C105
-10		Capacitor, 1000µf 35V, Electrolytic	1	C22
-11		Capacitor, 1800pf 50V SMT	1	C10,C11-
18				
-12		Capacitor, 27pf 50V SMT	3	C9,19, 20
-13		Capacitor, 1000µf 16V Low ESR	2	C3, 5
-14		Capacitor, 220µf 50V Low ESR	2	C1, 2
-15		Capacitor, 100µf 16V Electrolytic	1	C23
-16		Capacitor, .1µf 50V Ceramic Thru-Hole	3	C4, 6, 33
-17				
-18				
-19		Crystal, 32.768 kHz	1	X4
-20				
-21		Diode, 100ma, 50PIV BAS19	10	D3-11,20
-22				
-23		Relay, DPDT Form C SMT	1	K1
-24		Diode, Fast Switching, 1N5817	1	D12
-25		Diode, Schotky, 3A 1N5822	2	D1, 2
-26		LED, Red	2	LED1, 2
-27				
-28		IC 32-Bit CPU, SMT XC68332FE	1	U22
-29		IC DRAM, 64k x 4, 120ns SMT	8	U1-8
-30				
-31		IC Dual D Flip-Flop 74HC74	1	U25
-32		IC EIA-422 Line Driver SMT MC3487D	1	U10
-33		IC EIA-422 Line Receiver SMT MC3486D	1	U9
-34		IC Hex Schmidt Inverter SMT MC74HC14	1	U26
-35		IC LCD Gray Scale Controller CHIPS#82C445	1	U11
-36		IC Octal Bidirectional Buffer SMT 74HC245	5	U18-21, 28
-37				
-38		IC Power Switch Regulator LT1074	2	VR1, 2
-39		IC Quad NAND Gate SMT MC74HC00D	1	U17



800961-C Sept 2000

Fig. 4-2 PCB Assembly, Console (P/N 800888)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
4-2	800888	PCB Assembly, Console	Ref.	
-40		IC RAMified Timekeeper Dallas #DS1386-32	1	U13
-41		IC SRAM 32k x 8, 100ns	1	U12
-42		IC Switching Regulator National #LM3578AN	1	U23
-43		IC Voltage Monitor Circuit #MC34064D-5	1	U27
-44	800973	Firmware, Console, Fonts	2	U14,15
-45	800974	Firmware, Console, Program	1	U16
-46				
-47		Inductor, 25µh 2.5A #92100-K	1	L3
-48		Inductor 500µh Gowanda #1B503	1	L4
-49		Inductor, 70µh 3A #92104-K	2	L1, 2
-50				
-51		Inverter 12VDC In/1200VAC Out	1	INV1
-52				
-53		Socket, IC DIP 28-Pin	4	U12, 14-16
-54		Socket, IC DIP 32-Pin	1	U13
-55		Socket, IC DIP 8-Pin	1	U23
-56		Oscillator, 25.175MHz	2	X2, 3
-57		Oscillator, 28.322MHz	1	X1
-58		Resistor, 820K 1/8W SMT	1	R100
-59		Resistor, 261k 1/4W 5% Thru-Hole	1	R12
-60		Resistor, 820ý 1/4W 5% Thru-Hole	1	R15
-61		Resistor, 2k 1/4W 5% Thru-Hole	2	R4, 7
-62		Resistor, 220ý 1/4W 1/4W 5% Thru-Hole	1	R11
-63		Resistor, 82ý 1/4W 5% Thru-Hole	1	R10
-64		Resistor, 1k 1/4W 5% Thru-Hole	1	R8
-65		Resistor, 330ý 1/4W 5% Thru-Hole	1	R3
-66		Resistor, 110ý 1/4W 5% Thru-Hole	1	R9
-67		Resistor 82.5K 1/8W 1% SMT	1	R17
-68		Resistor, 2.87k 1/4W 1% Thru-Hole	1	R1
-69		Resistor, 2.21k 1/4W 1% Thru-Hole	2	R2, 6
-70		Resistor, 9.76k 1/4W 1% Thru-Hole	1	R5
-71		Resistor, .1ý 1W 1% Thru-Hole	1	R14
-72		Resistor, 3.9K 1/8W SMT	1	R101
-73		Resistor, 220k 1/8W SMT	1	R18
-74		Resistor, 100ý 1/8W SMT	9	R40-47, 82
-75		Resistor, 12.4k 1/8W 1% SMT	1	R81
-76		Resistor, 10MEG 1/8W SMT	1	R65
-77		Resistor, 10ý 1/8W SMT	6	R19, 20, 22-25
-78		Resistor, 110ý 1/8W SMT	3	R21, 83, --
85				

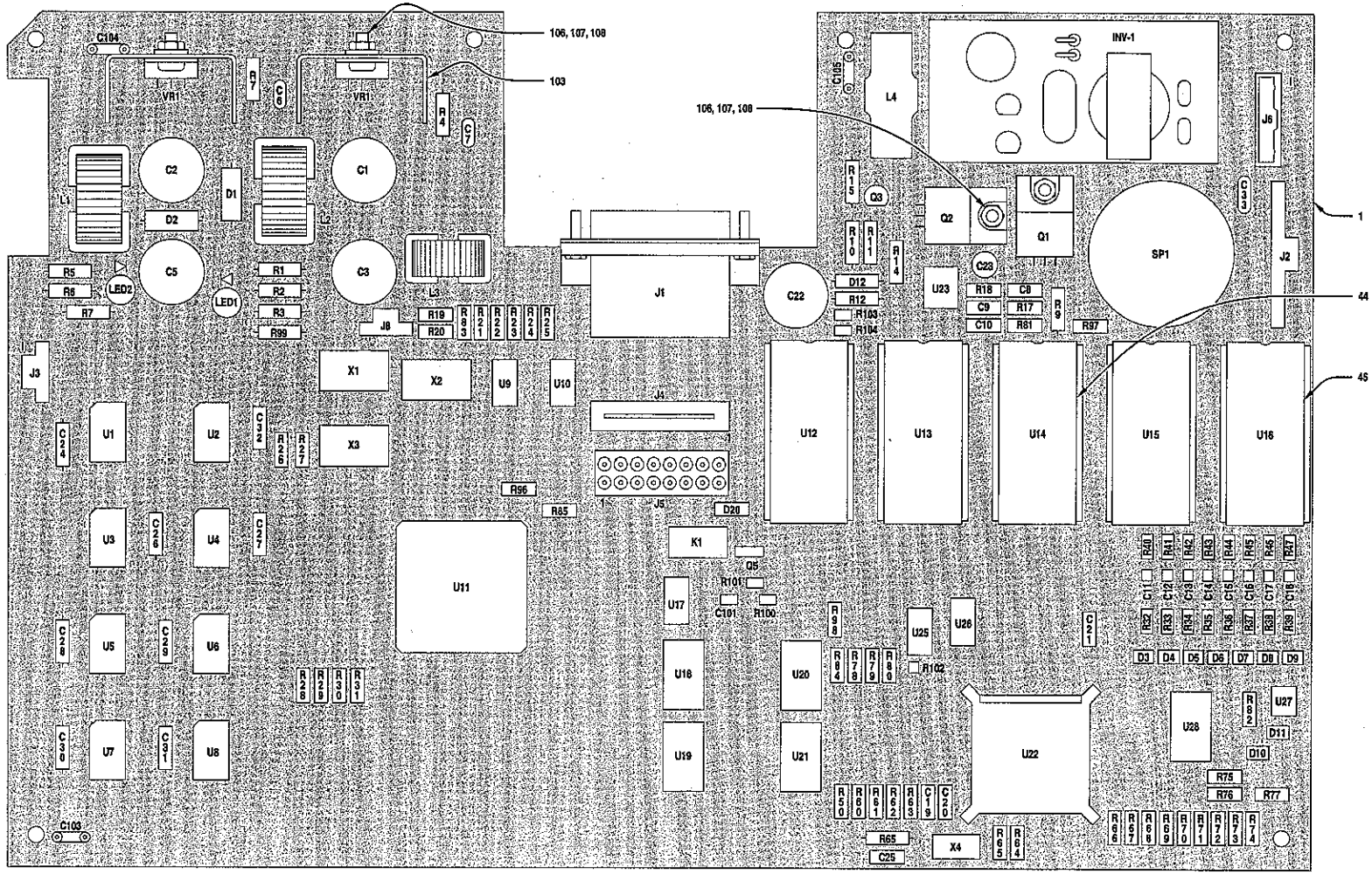


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Fig. 4-2 PCB Assembly, Console (P/N 800888)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
4-2	800888	PCB Assembly, Console	Ref.	
-79		Resistor, 68ý 1/8W SMT	6	R26-31
-80		Resistor, 4.7k 1/8W SMT	32	R17, 32-
39, 50; 60-63, 66-80, 84, 96,98				
-81		Resistor, 4.7K	1	R99
-82				
-83		Resistor, 18ý 1/8W SMT	2	R103,104
-84		Resistor, 330ý 1/8W SMT	1	R97
-85		Resistor, 330k 1/8W SMT	1	R64
-86		Speaker, 100ý	1	SP1
-87		Resistor, 220ý 1/8W SMT	1	R102
-88		Transistor, NPN 2N3904	1	Q3
-89		Transistor, PNP TIP-42	1	Q2
-90		FET, MTP15N05L	1	Q1
-91				
-92		Transistor, 2N3904 SMT	1	Q5
-93		Connector, DB-15, Pins	1	J1
-94		Connector, FFC-ZIF, 16-Position	1	J4
-95		Connector, MTE 10-Position	1	J2
-96		Connector, Mitsuba 6-Position	1	J6
-97		Connector, 4-Position	1	J3
-98		Connector, Ribbon Header 16 Position	1	J5
-99		Connector, 3-Position MTE	1	J8
-100				
-101				
-102				
-103		Heatsink, T220	2	VR1, 2
-104				
-105		Thermal Compound	A. R.	
-106		Screw, #4-40 x 3/8"	4	
-107		Washer, Lock, #4	4	
-108		Nut, Hex #4-40	4	

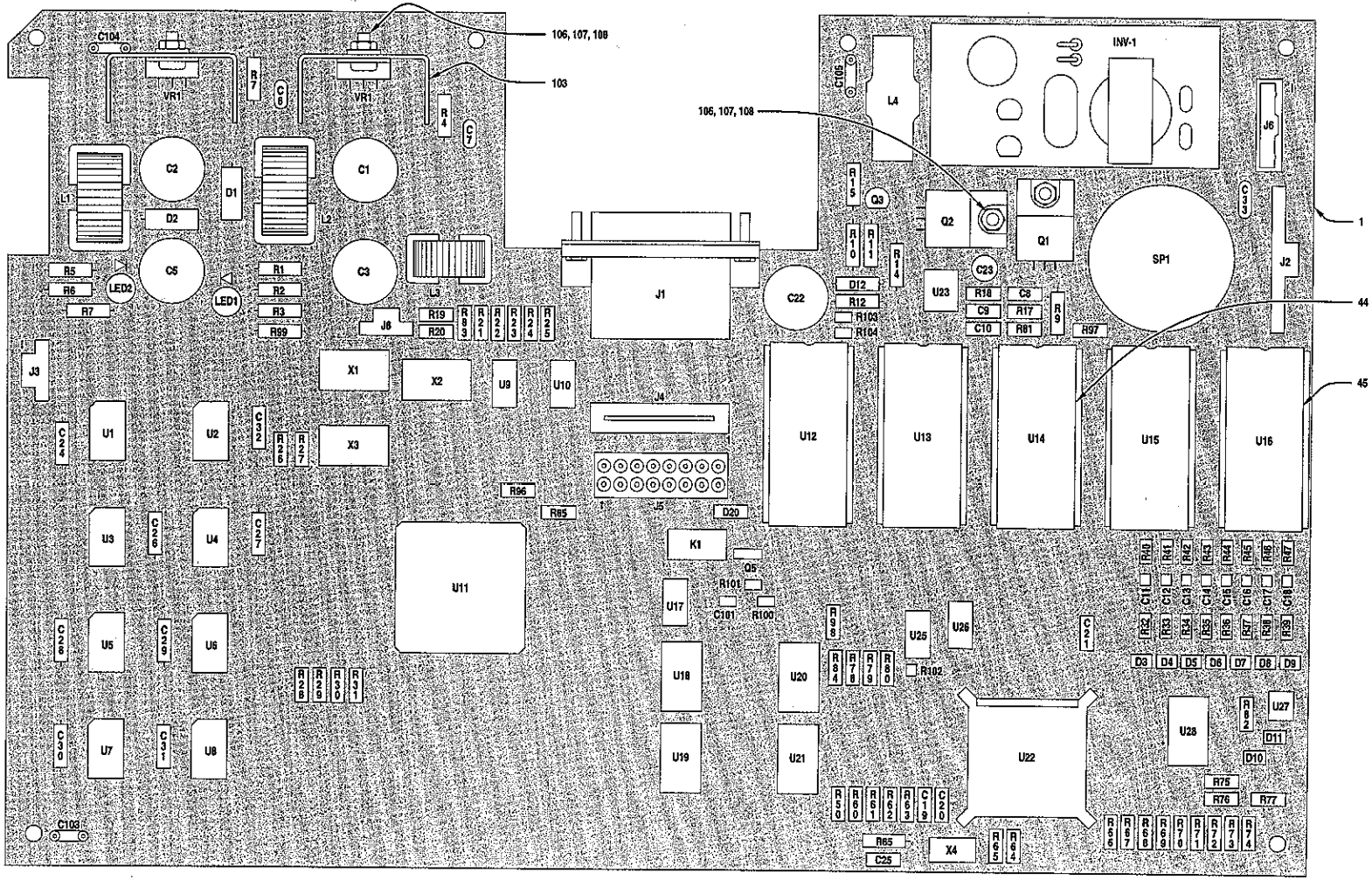

Fig. 4-2 PCB Assembly, Console (P/N 800888)

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SECTION IV-B
EL CONSOLE ASSEMBLY

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
4-1	800015	Console Assembly	Ref.	
-1	800271	Base, Console, Painted	1	
-2	800273	Bezel, Painted	1	
-3	800277	Switch Assembly, On/Off	1	
-4	800284	LCD Lens, Console, Anti-Glare	1	
-5	304E0004	Display, EL	1	
-6	800946	Key-Board, Console	1	
-7	800926	Power Light Assembly, Console	1	
-8	800405	Insulator, PCB	1	
-9		Screw, #6-32 x 1/4 Pan Head	8	
-10		Screw, #6-32 x 5/8 S.H. Cap	2	
-11		Screw, #6-32 x 1-1/8 S.H. Cap	2	
-12	800977	PCB Assembly, Console	1	
-13		Foam Tape, .016" x 1"	5/8"	
-14	800922	Harness Assembly., Key-Board	1	
-15	800278	Harness Assembly, Pot & On/Off Switch	1	
-16		Washer, #6, Lock Internal Tooth	6	
-17		Foot, Rubber	4	
-18		Washer, #6 Lock	4	
-19	800988	Gasket, Console-Rear Conn. PL.	1	
-20	800454	Label, High Voltage Warning	1	
-21		Black Silicon Rubber	A.R.	
-22	800450	Label, Part & Serial Number	1	
-23		Gasket	A.R.	
-24	800482	Label, Push On/Off switch	1	
-25		Gasket, Conductive Elastomer	39.00"	
-26	800254	Rear Connector Plate	1	
-27		Washer, #6 Flat	2	
-28	800515	Bracket, EMI Connector	1	
-29	800275	EL Bracket	1	
-30	800276	EL Support Brace	1	
-31		Washer, #6 Flat	1	
-32		Screw, #6-32 x 7/8" P.R. P.H.	2	
-33		Screw, #6-32 x 3/4 P.R. P.H.	1	
-34		Screw, #6-32 x 5/8" P.R. P.H.	1	

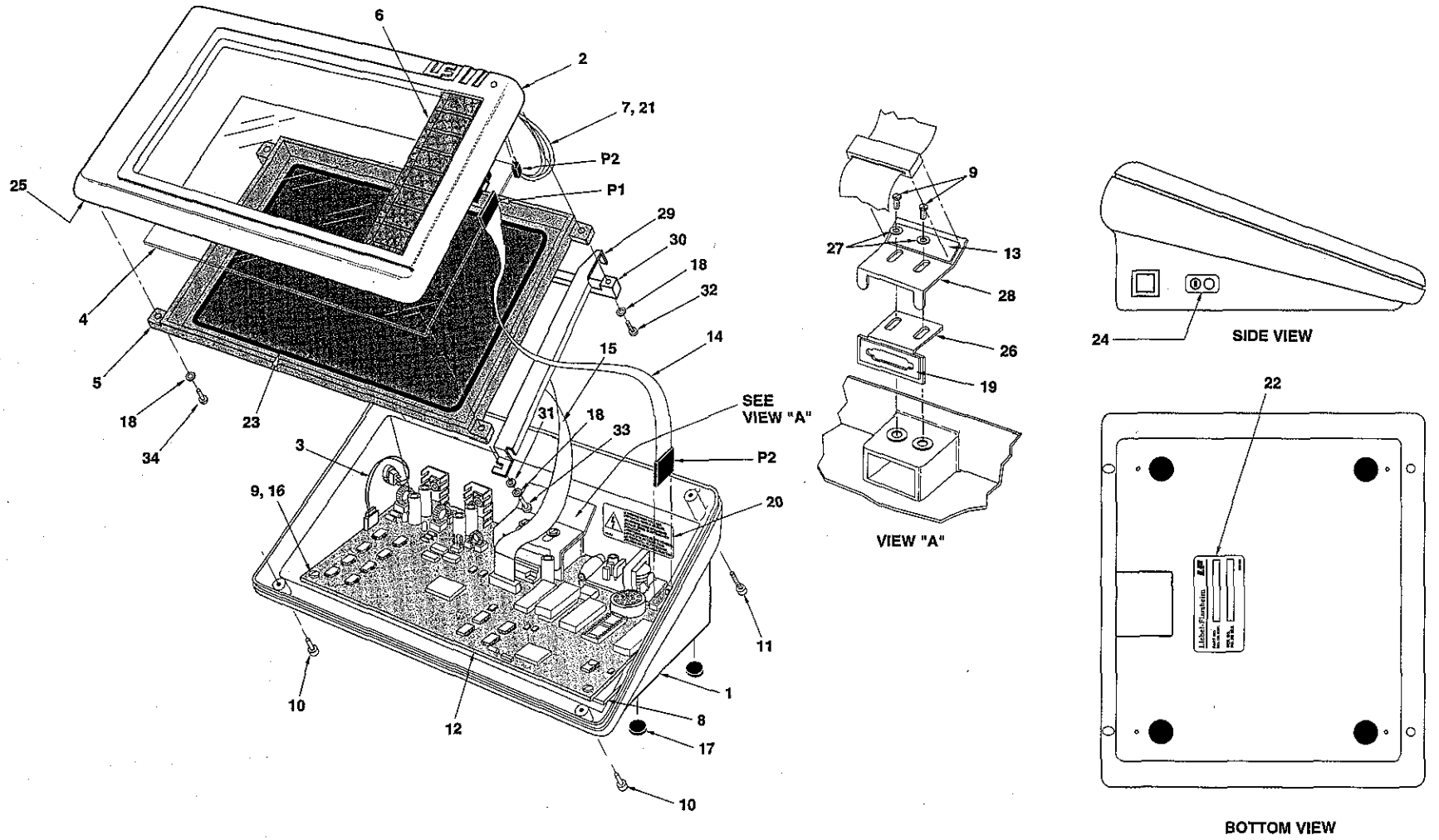

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Fig. 4-1-b Console Assembly (P/N 800015)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
4-2	800977	PCB Assembly, Console	Ref.	
-1		PCB Console, Multilayer	1	
-2				
-3		Capacitor, 2200pf 50V	1	C8
-4		Capacitor, .1µf 50V Axial Lead	8	C24,26-32
-5				
-6				
-7		Capacitor, .1µf Ceramic 50V SMT	3	C101, 21,
25				
-8				
-9		Capacitor, 1000pf, 1000V Ceramic	3	C103, C104,C105
-10		Capacitor, 1000µf 35V, Electrolytic	1	C22
-11		Capacitor, 1800pf 50V SMT	1	C10,C11-
18				
-12		Capacitor, 27pf 50V SMT	3	C9,19, 20
-13		Capacitor, 1000µf 16V Low ESR	2	C3, 5
-14		Capacitor, 220µf 50V Low ESR	2	C1, 2
-15		Capacitor, 100µf 16V Electrolytic	1	C23
-16		Capacitor, .1µf 50V Ceramic Thru-Hole	3	C4, 6, 33
-17				
-18				
-19		Crystal, 32.768 kHz	1	X4
-20				
-21		Diode, 100ma, 50PIV BAS19	10	D3-11,20
-22				
-23		Relay, DPDT Form C SMT	1	K1
-24		Diode, Fast Switching, 1N5817	1	D12
-25		Diode, Schotky, 3A 1N5822	2	D1, 2
-26		LED, Red	2	LED1, 2
-27				
-28		IC 32-Bit CPU, SMT XC68332FE	1	U22
-29		IC DRAM, 64k x 4, 120ns SMT	8	U1-8
-30				
-31		IC Dual D Flip-Flop 74HC74	1	U25
-32		IC EIA-422 Line Driver SMT MC3487D	1	U10
-33		IC EIA-422 Line Receiver SMT MC3486D	1	U9
-34		IC Hex Schmidt Inverter SMT MC74HC14	1	U26
-35		IC LCD Gray Scale Controller CHIPS#82C445	1	U11
-36		IC Octal Bidirectional Buffer SMT 74HC245	5	U18-21, 28
-37				
-38		IC Power Switch Regulator LT1074	2	VR1, 2
-39		IC Quad NAND Gate SMT MC74HC00D	1	U17

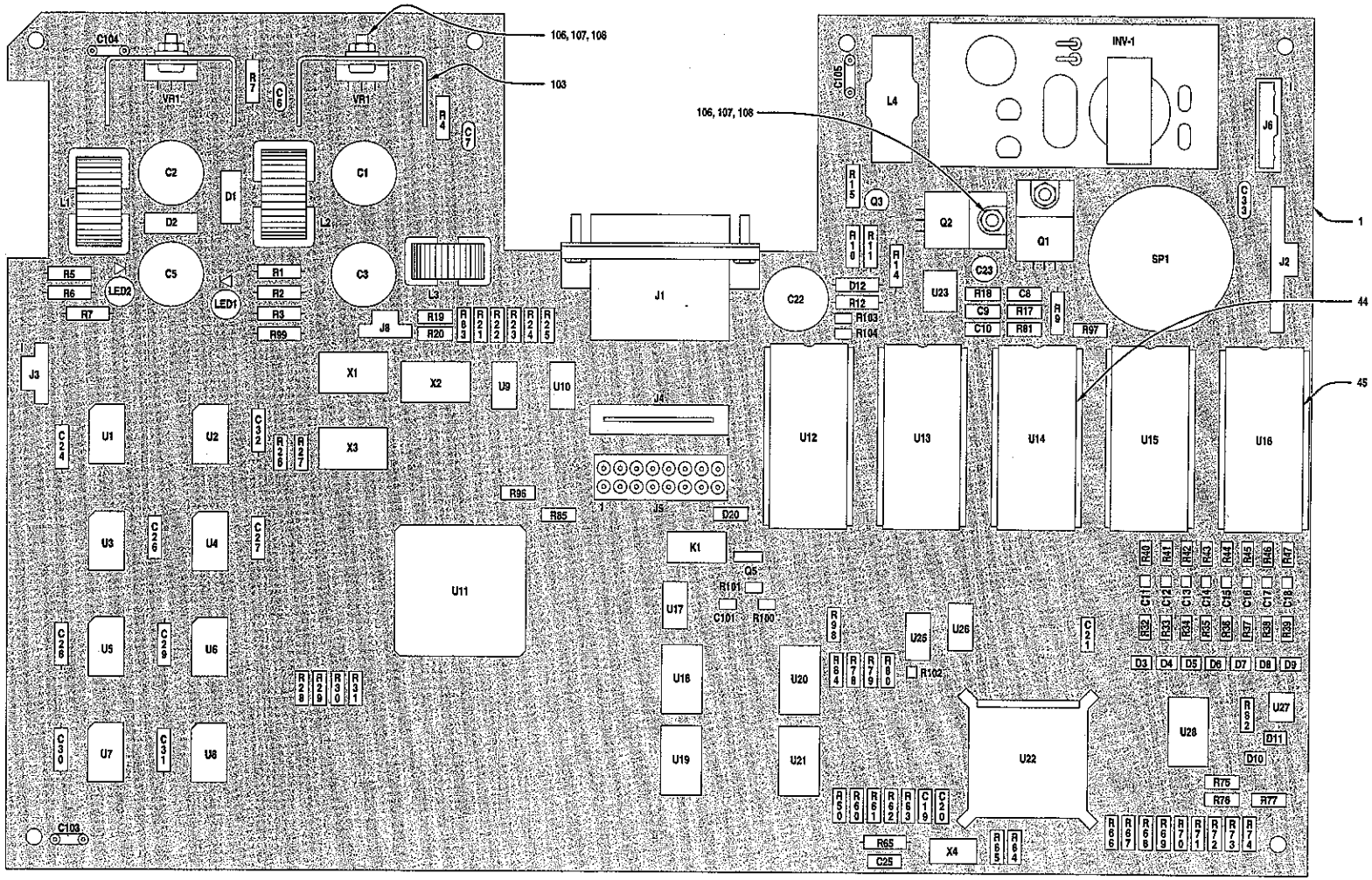

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Fig. 4-2 PCB Assembly, Console (P/N 800977)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
4-2	800977	PCB Assembly, Console	Ref.	
-40		IC RAMified Timekeeper Dallas #DS1386-32	1	U13
-41		IC SRAM 32k x 8, 100ns	1	U12
-42		IC Switching Regulator National #LM3578AN	1	U23
-43		IC Voltage Monitor Circuit #MC34064D-5	1	U27
-44	800973	Firmware, Console, Fonts	2	U14,15
-45	800982	Firmware, Console, Program	1	U16
-46				
-47		Inductor, 25µh 2.5A #92100-K	1	L3
-48		Inductor 500µh Gowanda #1B503	1	L4
-49		Inductor, 70µh 3A #92104-K	2	L1, 2
-50				
-51		Inverter 12VDC In/1200VAC Out	1	INV1
-52				
-53		Socket, IC DIP 28-Pin	4	U12, 14-16
-54		Socket, IC DIP 32-Pin	1	U13
-55		Socket, IC DIP 8-Pin	1	U23
-56		Oscillator, 25.175MHz	2	X2, 3
-57		Oscillator, 28.322MHz	1	X1
-58		Resistor, 820K 1/8W SMT	1	R100
-59		Resistor, 261k 1/4W 5% Thru-Hole	1	R12
-60		Resistor, 820ý 1/4W 5% Thru-Hole	1	R15
-61		Resistor, 2k 1/4W 5% Thru-Hole	2	R4, 7
-62		Resistor, 220ý 1/4W 1/4W 5% Thru-Hole	1	R11
-63		Resistor, 82ý 1/4W 5% Thru-Hole	1	R10
-64		Resistor, 1k 1/4W 5% Thru-Hole	1	R8
-65		Resistor, 330ý 1/4W 5% Thru-Hole	1	R3
-66		Resistor, 110ý 1/4W 5% Thru-Hole	1	R9
-67		Resistor 82.5K 1/8W 1% SMT	1	R17
-68		Resistor, 2.87k 1/4W 1% Thru-Hole	1	R1
-69		Resistor, 2.21k 1/4W 1% Thru-Hole	2	R2, 6
-70		Resistor, 9.76k 1/4W 1% Thru-Hole	1	R5
-71		Resistor, .1ý 1W 1% Thru-Hole	1	R14
-72		Resistor, 3.9K 1/8W SMT	1	R101
-73		Resistor, 220k 1/8W SMT	1	R18
-74		Resistor, 100ý 1/8W SMT	9	R40-47, 82
-75		Resistor, 12.4k 1/8W 1% SMT	1	R81
-76		Resistor, 10MEG 1/8W SMT	1	R65
-77		Resistor, 10ý 1/8W SMT	6	R19, 20, 22-25
-78		Resistor, 110ý 1/8W SMT	3	R21, 83, 85

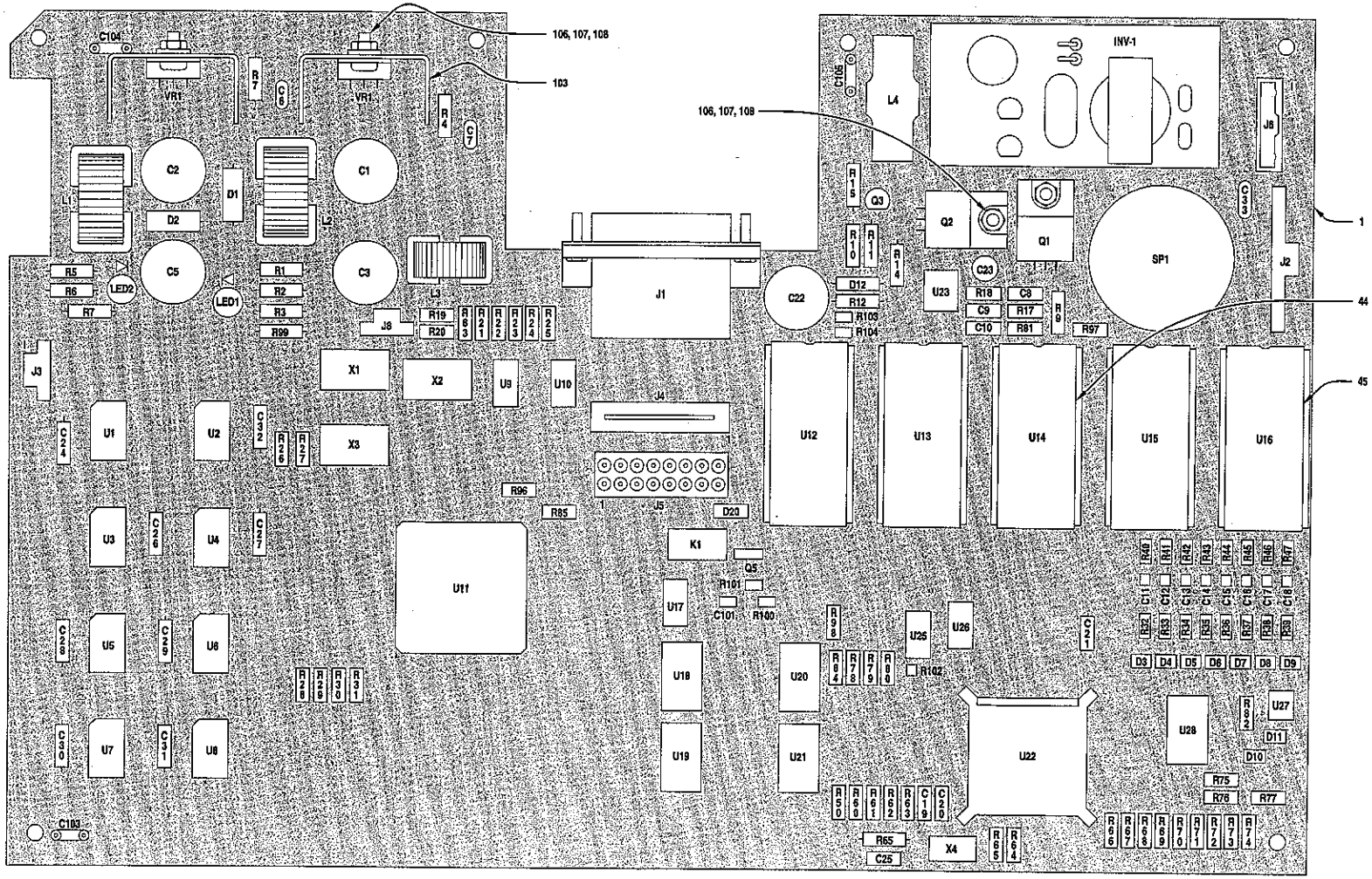

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Fig. 4-2 PCB Assembly, Console (P/N 800977)

Fig. & Index No.	Part Number	Description	Units Per Ass'y.	Component Designator
4-2	800977	PCB Assembly, Console	Ref.	
-79		Resistor, 68ý 1/8W SMT	6	R26-31
-80		Resistor, 4.7k 1/8W SMT	32	R17, 32-39, 50, 60-63, 66-80, 84, 96,98
-81		Resistor, 4.7K	1	R99
-82				
-83		Resistor, 18ý 1/8W SMT	2	R103,104
-84		Resistor, 330ý 1/8W SMT	1	R97
-85		Resistor, 330k 1/8W SMT	1	R64
-86		Speaker, 100ý	1	SP1
-87		Resistor, 220ý 1/8W SMT	1	R102
-88		Transistor, NPN 2N3904	1	Q3
-89		Transistor, PNP TIP-42	1	Q2
-90		FET, MTP15N05L	1	Q1
-91				
-92		Transistor, 2N3904 SMT	1	Q5
-93		Connector, DB-15, Pins	1	J1
-94		Connector, FFC-ZIF, 16-Position	1	J4
-95		Connector, MTE 10-Position	1	J2
-96		Connector, Mitsuba 6-Position	1	J6
-97		Connector, 4-Position	1	J3
-98		Connector, Ribbon Header 16 Position	1	J5
-99		Connector, 3-Position MTE	1	J8
-100				
-101				
-102				
-103		Heatsink, T220	2	VR1, 2
-104				
-105		Thermal Compound	A. R.	
-106		Screw, #4-40 x 3/8"	4	
-107		Washer, Lock, #4	4	
-108		Nut, Hex #4-40	4	

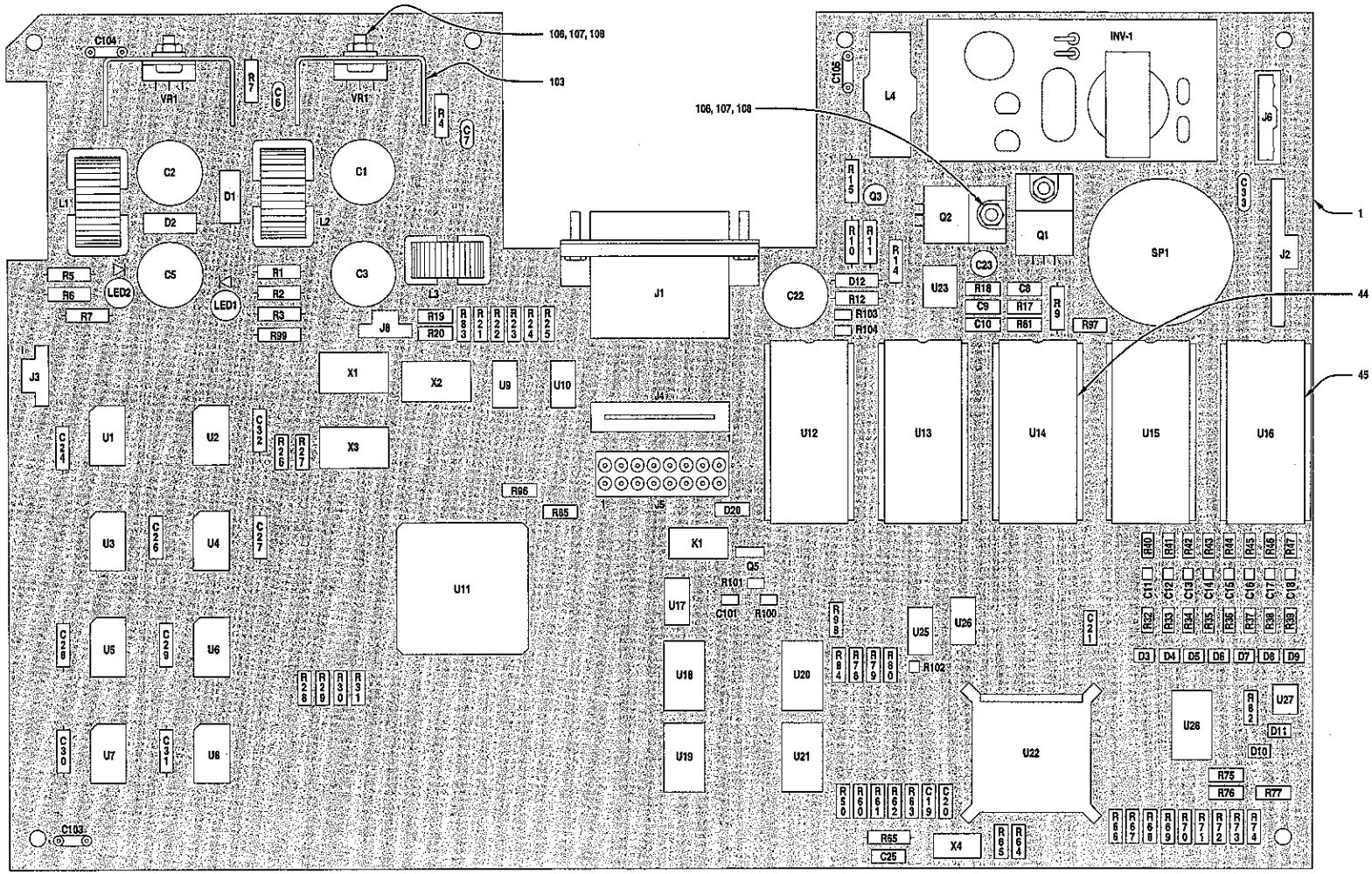

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Fig. 4-2 PCB Assembly, Console (P/N 800977)

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CT 9000 ADV
Preventive Maintenance Checklist

Base/Elect Cab S/N | | | | | | | | |

Powerhead S/N | | | | | | | | |

Console S/N | | | | | | | | |

Model Number | | | | | | | | |

Customer _____

This Checklist is to be used in conjunction with Chapter 6 of Installation and Service Manual 800961.

POWERHEAD

VISUAL INSPECTION

- ❑ 1. Check Heater Blanket and Cable.
- ❑ 2. Inspect the pressure jacket.
- ❑ 3. Inspect the ram assembly.
- ❑ 4. Check the syringe gripper for proper operation.
- ❑ 5. Check the pivot assembly.
- ❑ 6. Check the powerhead cable connector.
- ❑ 7. Check the powerhead cable.
- ❑ 8. Check face-plate assemblies.

CONSOLE

VISUAL INSPECTION

- ❑ 1. Check the console cable.
- ❑ 2. Check the key pad.
- ❑ 3. Check the assembly for damage.

POWER PACK

VISUAL INSPECTION

- ❑ 1. Check the power cord.
- ❑ 2. Check the optional and external cables.
- ❑ 3. Check all connectors.
- ❑ 4. Check that the cover is secure.

PEDESTAL

VISUAL INSPECTION

- ❑ 1. Check column assembly.
- ❑ 2. Check the base assembly.

OPERATIONAL CHECK OUT

See Chapter 6 for procedures.

- ❑ 1. Power-up Check (Chapter 6).
- ❑ 2. Power-head/Pressure Jacket check.
- ❑ 3. Console Check.
- ❑ 4. Flow Rate/Check.
- ❑ 5. Pressure Limit Check.

Customer Signature **Date**

_____

Service Representative **Date**

_____

CT 9000® ADV Installation Checklist

Console S/N | | | | | | | | |

Power pack S/N | | | | | | | | |

Powerhead S/N | | | | | | | | |

Model Number | | | | | | | | |

Customer _____

This Checklist is to be used in conjunction with Chapter 2 and 6 of the Installation and Service Manual.

Refer to Chap. 2 of the Install. and Service Manual.

INSTALLATION PROCEDURE

- ❑ Inspect Console.
- ❑ Inspect Power Pack.
- ❑ Inspect Powerhead.
- ❑ Inspect Cables and Power Cord.
- ❑ Inspect each accessory.
- ❑ Mount components to desired configuration.
- ❑ Connect cabling.
- Install Pressure Plate Assembly.

Powerhead/Pressure Jacket

- ❑ Check pressure jacket.
- ❑ Inspect the ram, seals and heater connector
- ❑ Check the powerhead pivot movement.
- ❑ Check powerhead keys.
- ❑ Check ram.
- ❑ Check pressure jacket plate latch.
- ❑ Check the volume indicator LED.

Keyboard Console

- ❑ Check Console keys and Remote Start switch.

Electronics Cabinet

- ❑ Check the volume indicatior LED.

Flow Rate Check

- ❑ Enter an Injection.
- ❑ Enable the injection.
- ❑ Verify display
- ❑ Expected Duration: between 4 and 20 seconds, depending on pressure plate.
- ❑ Verify Enable light is illuminated.
- ❑ Verify correct tracking and injecting light is illuminated.
- ❑ "Achieved Values" are within tolerances
- ❑ Second injection "Achieved Values" are within tolerances.
- ❑ Third injection "Achieved Values" are within tolerances.